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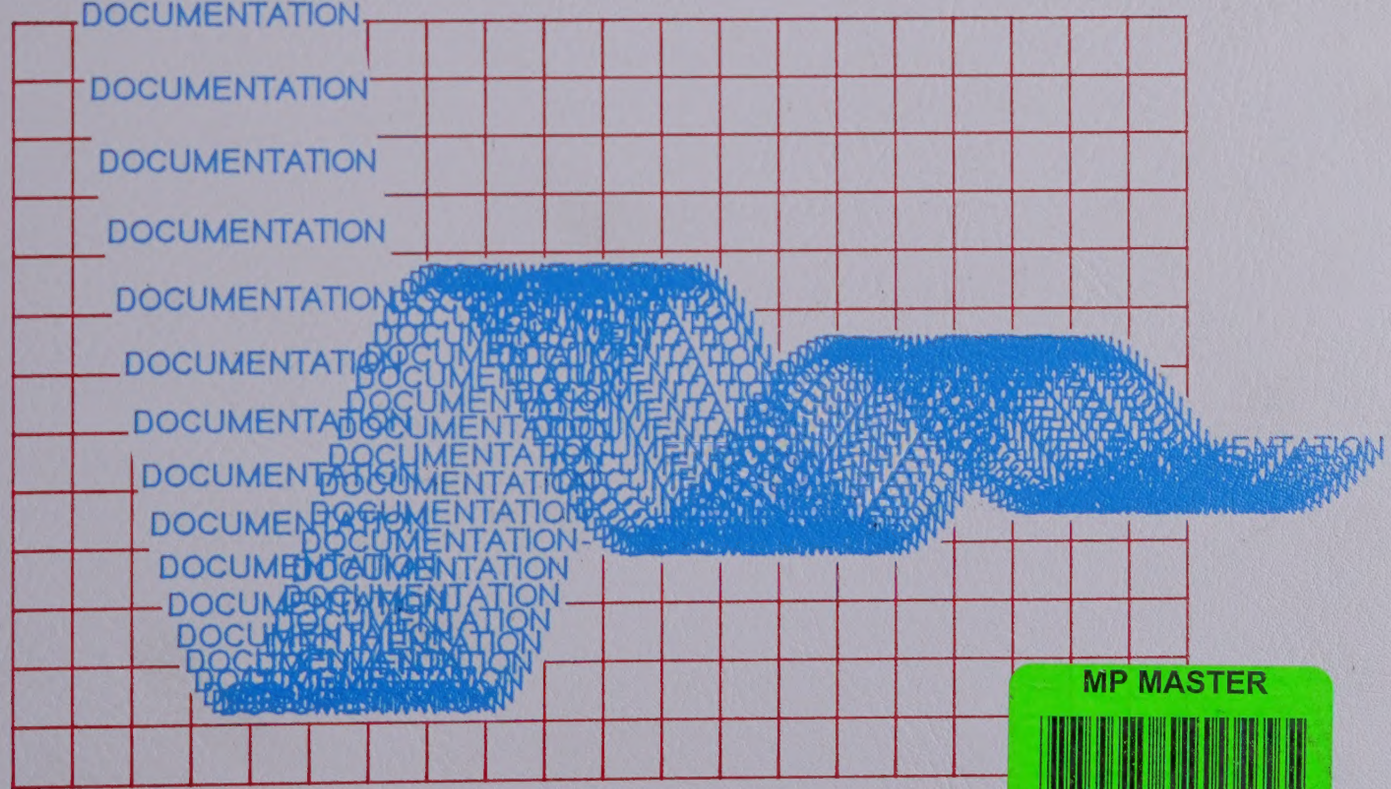

MP MASTER
MA34518

ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

AUDIO ANALYZER
UPL/UPL16/UPL66

DC to 110 kHz

1078.2008.06/16/66

Software version UPL 1.30

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Tabbed Divider Overview

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Data Sheets

Safety Instructions
Certificate of quality
EC Certificate of Conformity
List of R & S Representatives

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Audio Analyzer UPL

The solution for the budget-conscious

- For all interfaces: analog, digital and combined
- Real dual-channel measurements
- Maximum dynamic range
- FFT analysis
- Jitter analysis
- Interface tester
- Freely programmable filters
- Versatile functions
- Compact unit with integrated PC
- Automatic test sequences
- Extensive online help

ROHDE&SCHWARZ

Audio analysis today and tomorrow

Analog and digital

Audio signal processing is nowadays no longer conceivable without the use of digital techniques. Yet, analog technology continues to exist and undergoes constant improvement. State-of-the-art measuring instruments must therefore be able to handle both analog and digital signal processing.

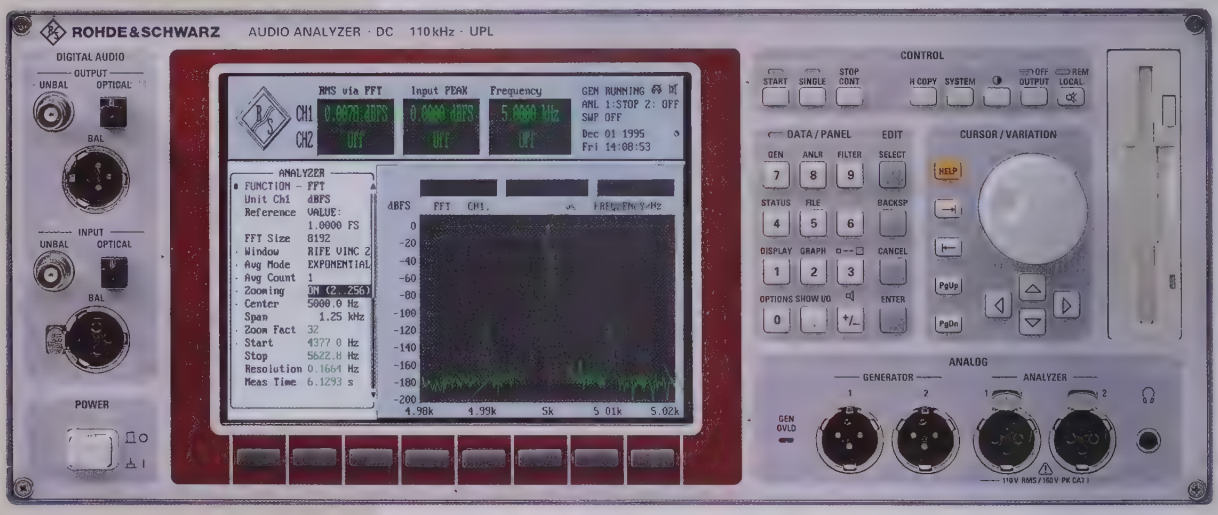
The generator is every bit as versatile: it supplies any conceivable signal from sinewave and noise signals through to multi-sinewave signals comprising up to 7400 frequencies.

In addition to all this, UPL features excellent technical data: analog sinewave generation with harmonics of typ. –120 dB, spectrum displays with a noise floor below –140 dB for analog and –160 dB for digital interfaces, FFT with a maximum frequency resolution of 0.05 Hz, etc.

UPL provides signal monitoring via loudspeaker during the test, jitter measurements on digital audio signals, resynchronization of jittered digital audio signals by means of a jitter-free clock signal, and many more features.

Superior analysis concept

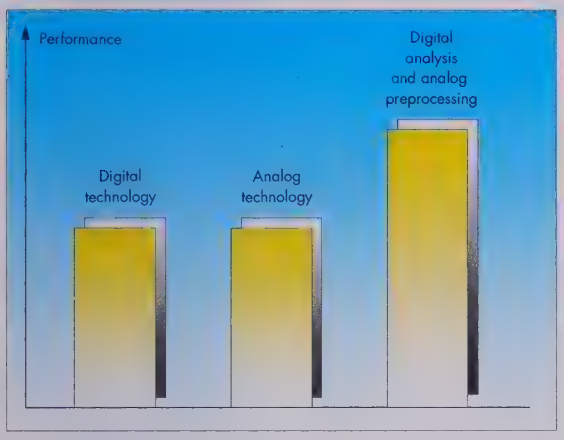
UPL performs all measurements using digital signal processing. Analog signals to be tested undergo elaborate preprocessing before they are digitized and measured by means of digital routines. For example, in THD measurements, the fundamental wave is attenuated by means of a notch filter and the residual signal amplified by 30 dB before it is digitized. In this way, the dynamic range can be extended beyond that offered by the internal 20-bit converter. This provides the scope required for measuring future converters, which will be technically more advanced than present-day devices (see graph on the right). This concept guarantees a performance and flexibility by far superior to instruments providing purely analog or digital measurements.



Audio Analyzer UPL performs practically all types of analog measurement, from frequency response measurements through to externally controlled sweeps with reference traces, determination of 3rd-order difference frequency distortion, spectral display of demodulated wow and flutter signals, etc. In contrast to many other audio analyzers, UPL is capable of performing real dual-channel measurements in the audio-frequency range, ie there is no need for switchover between two inputs and this facility is not limited to a few special cases.

The above measurement concept offers many more advantages over merely analog concepts:

- The test routines performed on analog and digital interfaces are identical. This allows, for instance, the direct comparison of IMD measurements made ahead of and after a converter.
- In intermodulation measurements, spurious components are measured selectively for all frequencies in accordance with the mathematical formula of the relevant test standards. This procedure avoids the measurement of adjacent components along with the spuria, which is usually inevitable with analog test methods.



The intelligent combination of analog and digital measurement techniques paves the way for future applications

- All test functions are available both on the analog and the digital interfaces. This makes it possible to measure at any point of a common analog and digital transmission path. Only this ensures efficient and complete testing.
- The filters, too, were implemented digitally, resulting in an infinite number of filters as it were, and this also for measurements on analog interfaces. Just choose the type of filter (eg highpass), cutoff frequency and attenuation: that's all you have to do to loop a new filter into the test path.
- Measurement speed is as a rule higher than with analog techniques since digital test routines can adapt their speed to the input frequency. And – last but not least:
- Operation is the same for the analog and the digital interfaces. A feature that should not be underestimated.

Certified Quality System
ISO 9001

A future-proof investment

Nobody can accurately predict today what effects future developments in digital technology will have on the audio world and what will be the resulting test requirements. This is however no problem for Audio Analyzer UPL. Since all test functions are implemented digitally, UPL can be adapted to changing requirements by simply loading the necessary software – and this also for the analog interfaces.

And one more thing: Rohde & Schwarz is the only manufacturer to equip its audio analyzers with 32-bit floating-point signal processors throughout, thus offering plenty of reserves beyond the limits of today's common 24-bit technology.

A competent partner

The name of Rohde & Schwarz stands for excellent quality – thousands of audio analyzers have proven records at satisfied customers and have been in operation successfully for many years. After the purely analog UPA and UPD, which still holds the top position in today's audio measurement technology, Audio Analyzer UPL has been developed to complete the program.

As a competent partner we shall be pleased to advise you on the optimum use of our instruments. Our representatives are available for you all over the world, and our customer support center and application engineers in Munich are there to help you find the right solution to your measurement tasks. In addition, you will find a wealth of proposals and solutions in our application notes and software.

Naturally, Rohde & Schwarz instruments are certified in compliance with ISO 9001.

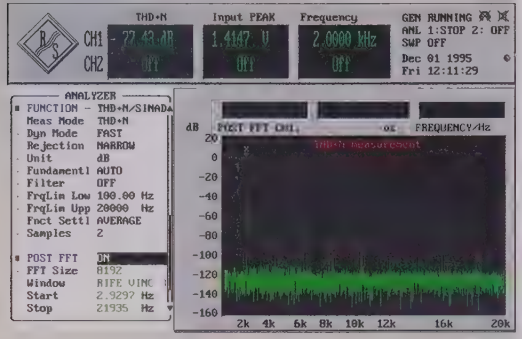


Fig. 1: Automatic marking of harmonics in THD+N measurements makes nonharmonics visible at a glance

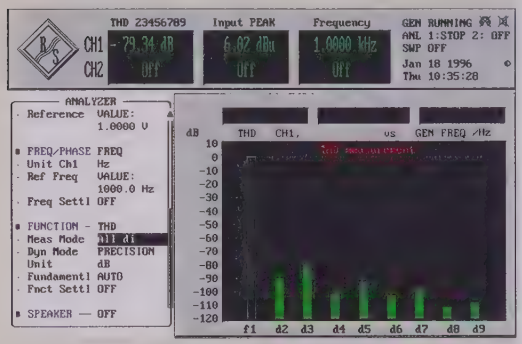


Fig. 2: In THD measurements, single harmonics, all harmonics or any combination of harmonics can be measured

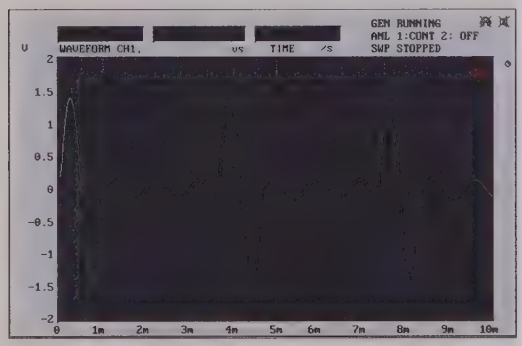


Fig. 3: The waveform function displays the test signal in the time domain. The example shows a sinewave burst

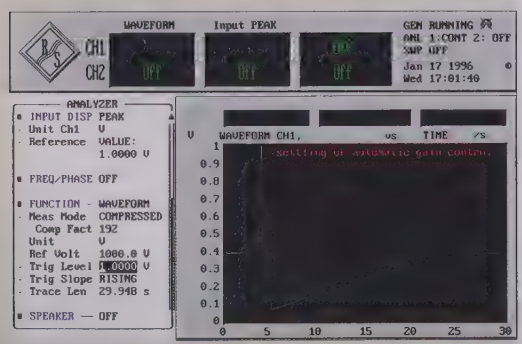


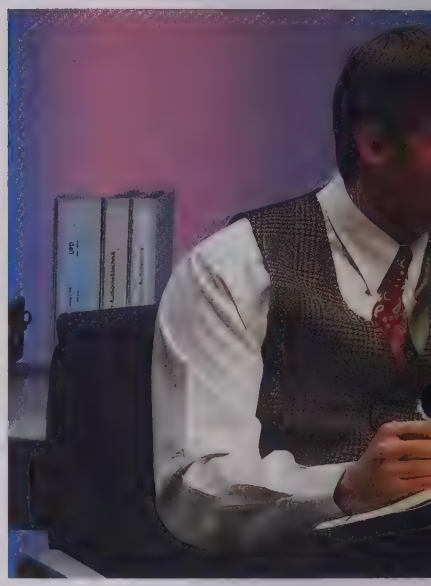
Fig. 4: The transient characteristics of an AGC play an important role in testing hearing aids or automatic volume control on tape recorders

An allrounder

Versatile test functions

UPL offers a wealth of measurement functions both for analog and – with option UPL-B2 – digital interfaces.

- **Level or S/N**
  with rms, peak or quasi-peak weighting.
- **Selective level**
  The center frequency of the band-pass filter can be swept or coupled to the generator frequency, to the frequencies of a multitone signal (eg for fast frequency response measurements) or to the input signal.
- **SINAD or (THD+N)**
  The sum of all harmonics and noise is measured (Fig. 1).
- **Total harmonic distortion (THD)**
  Single harmonics, all the harmonics or any combination of harmonics can be measured (Fig. 2).
- **Modulation distortion**
  to DIN-IEC 268-3. 2nd and 3rd order intermodulation is measured.
- **Intermodulation**
  using the difference tone method. 2nd and 3rd order intermodulation is measured.
- **Wow and flutter**
  to DIN IEC, NAB, JIS or the 2-sigma method to DIN IEC where the demodulated-signal spectrum is also displayed.
- **Polarity test**
  for checking signal paths for reversed polarity.
- **Crosstalk**
- **Waveform function**
  for representing the test signal in the time domain (Fig. 3). Waveforms can be smoothed by interpolation. Slow sequences can be displayed compressed, eg for analyzing the transient response of compander or AGC circuits (Fig. 4).



- **Extended analysis functions**
  with option UPL-B6; coherence and transfer functions; rub & buzz, etc.
- **DC voltage**
- **Frequency, phase and group delay**

Test signals – as you like it

The generators of UPL supply an extremely wide variety of analog and – with option UPL-B2 – digital test signals:

- **Sinewaves**
  for level and harmonic distortion measurements. The signal can be applied to an equalizer with user-selectable nominal frequency response, eg for compensating the frequency response of the test assembly.
- **Two-tone signal**
  for modulation distortion analysis. Various amplitude ratios can be selected and the frequencies are continuously adjustable.

- **Difference tone signal**
  for intermodulation measurements with continuous setting of both frequencies.
- **Special multitone signal**
  comprising up to 7400 frequencies with selectable amplitude distribution. The frequency spacing can be linked to the resolution used for the Fast Fourier Transform, thus enabling rapid and precise single-shot measurements of the frequency response of a DUT.
- **Multitone signal**
  comprising up to 17 sinewaves of any frequency and with the same or different levels; setting of phase with UPL-B6
- **Sine burst signal**
  with adjustable interval and on-time and programmable low level, eg for testing AGCs.
- **Sine² burst**
  also with adjustable interval and on-time, eg for testing rms rectifier circuits.
- **Noise**
  with a variety of probability distributions, eg for acoustic measurements; setting of crest factor with UPL-B6
- **Arbitrary waveforms**
  for generating any voltage curve of up to 16k points.

Signals can be measured with an offset, digital audio signals can be dithered with adjustable level, and selectable amplitude distribution can be added to digital audio signals.

A variety of sweep functions

For continuous variation of the test signals, UPL offers amplitude and frequency sweeps and for bursts additionally sweeps of the interval and the on-time. Sweeps are defined either by means of a table or via parameters such as start value, number of steps, linear/log stepping or time interval. It is also possible to sweep two variables simultaneously.

In measurements of external signals, these can be used for analyzer sweeps (external sweeps). Many different start conditions can be set, allowing measurements to be triggered by a variety of events. Results will be stable even for DUTs with unknown or unstable transient response thanks to the settling function.

Tests on hi-fi components call for increasingly complex measurement techniques. Results obtained in the test lab must be verified in production, where as a rule not the whole range of test functions is needed but economical solutions to cater for large batches. UPL is an ideal choice for this task, and it optimally complements its "bigger brother", Audio Analyzer UPD, which is mainly employed in development. The operating concept of the two units based on the same IEC/IEEE-bus commands is identical, so there is no problem using them jointly.

Fast and efficient

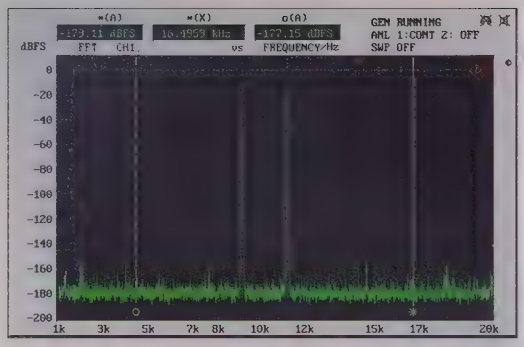


Fig. 5: FFT spectrum of two-tone signal shown on full screen

Fig. 6: With the zoom FFT function, sidebands spaced only a few hertz from the signal can be displayed

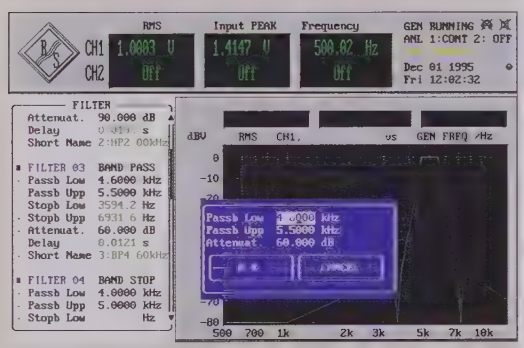


Fig. 7: Filters can be defined by entering just a few parameters

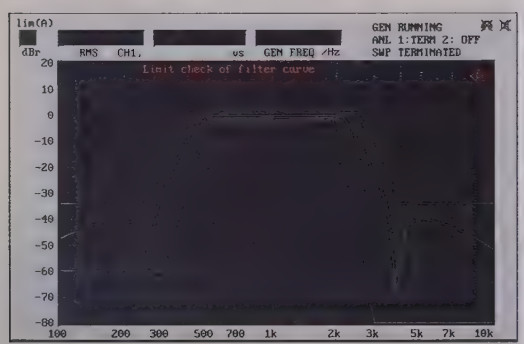


Fig. 8: Tolerance curves enable fast go/nogo tests

Spectral analysis

With its FFT analyzer, UPL is also capable of spectrum analysis. The number of samples for Fast Fourier Transform can be selected between 256 and 16k in binary steps (Fig. 5). A special feature is zoom FFT. The signal to be measured is digitally preprocessed to increase the frequency resolution by a factor of 2 to 128 over a selectable range. In this way, a maximum resolution of 0.05 Hz is attained. It should be emphasized that this is not just a scale expansion but the measurement is really made at a higher resolution (Fig. 6).

Programmable filters

The filters of UPL are software-implemented so that the user can define any number of filters. The most common weighting filters are provided as standard. Further filters can be programmed in a few seconds by entering the type (lowpass, highpass, bandpass, bandstop, notch, third octave or octave), frequency and attenuation (Fig. 7). The instrument's open architecture shows its strength in particular where special requirements have to be met: special filters can be implemented using commercial filter design programs. The data are transferred to UPL and the designed filter looped into the signal path.

High measurement speed

In designing Audio Analyzer UPL, particular emphasis was placed on optimizing the measurement speed of the test system as a whole:

- All operations involving elaborate computing are carried out by digital signal processors. The PC is merely used for control of the unit and display of results.
- UPL can perform even complex test functions simultaneously on both channels. This feature alone reduces the time for stereo measurements by 50% compared with most analyzers available on the market.
- The digital test routines adapt their speed optimally to the input frequency. This enhances measurement speed especially in the case of frequency sweeps.
- UPL performs harmonic distortion and IMD measurements using patented, digital test procedures that combine high accuracy with high measurement speed.
- Digital signal processing even reduces setting and transient times achievable with purely analog instruments. These times are also taken into account in the test routines, yielding stable measurements without the need for activating settling functions (these are understood to be repeated measurements until results are within a tolerance band).
- The user interface was tailored to the requirements of a test, not of an office environment.

High measurement speed, two-channel measurements and remote-control capability via the IEC/IEEE bus are a must in production systems. The long calibration intervals of UPL make for high availability and reduce running costs.

- Any display panels not needed can be switched off, which also cuts down the processing time. When all displays are switched off and results are output via the IEC/IEEE bus, more than 100 level measurements per second can be made.

Use in production

Instruments to be used in production tests must satisfy a variety of requirements:

- High measurement speed is vital for achieving a high production throughput. By making appropriate use of the instrument functions, go/nogo decisions can be made already in the audio analyzer, thus reducing the run time of a DUT (Fig. 8).
- Two-channel measurements allow the simultaneous and thus time-saving determination of input and output characteristics.
- The use of FFT analysis provides a decisive advantage especially in the case of frequency response measurements, which are particularly time-critical. Example: 900 frequency values in 150 ms.
- Long calibration intervals, resulting from the extensive use of digital circuits, make for high availability of the instrument.
- Model UPL66 is specially tailored to the requirements of production. UPL66 comes without a display and keypad, thus saving purchasing costs. Yet the unit can be operated manually by connecting a PC keyboard and a VGA monitor, enabling fast fault localization in the event of production problems.
- Remote-control capability via the IEC/IEEE bus is a must in large-scale production systems. In the design of Audio Analyzer UPL, special importance was attached to data transfer via the IEC/IEEE bus. The logging mode can be used to speed up the generation of control programs for the IEC/IEEE bus. With the program generator provided in UPL-B10, it is no longer necessary to look up IEC/IEEE-bus commands.

UPL66 – special model for use in test systems, with the full flexibility of the standard model

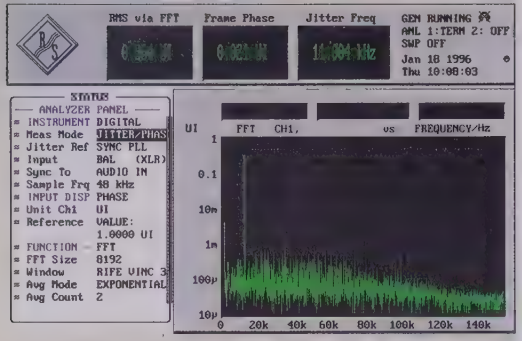


Fig. 9: Individual interference components can easily be found with the aid of the jitter spectrum.

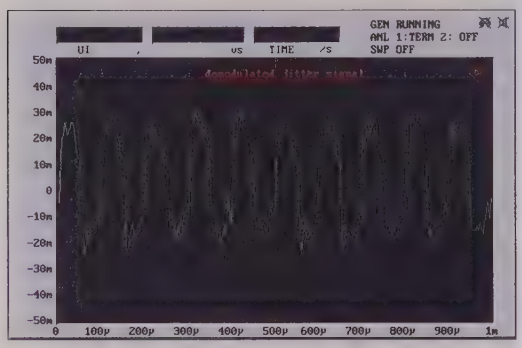


Fig. 10: Display of jitter signal in time domain

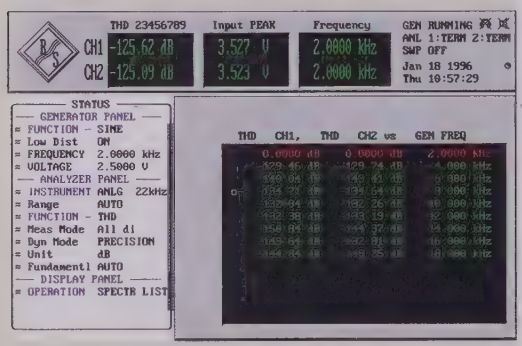


Fig. 11: Complete measured-value tables can be output for all functions

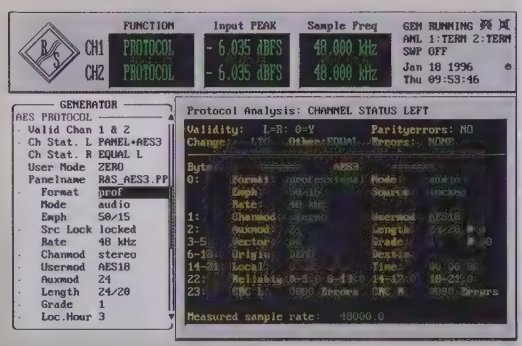


Fig. 12: UPL generates and analyzes additional data in digital data streams in line with all common standards. The data are represented in binary form, as hexadecimal numbers, as ASCII characters or evaluated in consumer or professional format

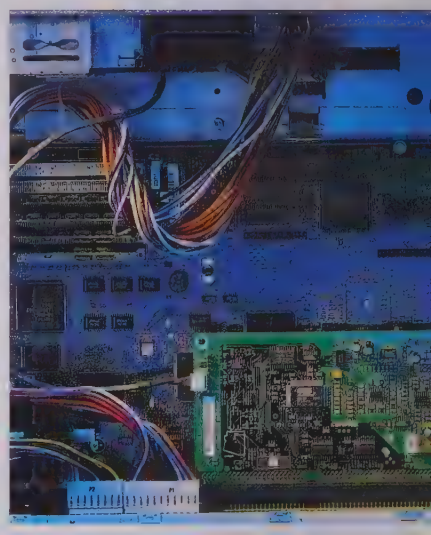
Interfaces, protocol analysis, jitter

Analog interfaces

- Balanced inputs with high common-mode rejection and various impedances commonly used in the studio. Measurements can be made on lines with phantom feed.
- Balanced outputs, floating (to prevent hum loops).
- The generator outputs can be internally connected to the analyzer inputs so that different types of measurement can be made without the need for changing the cabling.

Digital audio interfaces (option UPL-B2)

- Balanced (XLR), unbalanced (BNC) and optical (TOSLINK) inputs and outputs for connecting consumer electronics and professional studio equipment.
- The levels of the balanced and unbalanced outputs are adjustable so that the sensitivity of digital audio inputs can be determined.
- The format of the generated channel status data may be professional or consumer independent of the selected interface.
- A reference (XLR) and a synchronization (BNC) input provided on the rear panel allow both the analyzer and the generator to be synchronized to the digital audio reference signal (DARS) to AES 11, and the generator in addition to word-clock, video sync signals (PAL/SECAM/NTSC) and to 1024-kHz reference clocks.
- The generator as well as the analyzer can be driven with clock rates of 27 to 55 kHz. The clock signals can also be produced internally by the generator.
- The clock rates of the analyzer and generator are independent of each other. This allows measurements on sample converters.
- The word length can be selected between 8 and 24 bits independently for generator and analyzer.



Improvement of audio quality of sound cards and media equipment – a task for UPL

Digital protocol analysis and generation (option UPL-B21)

This software option extends the functions of option UPL-B2 by an in-depth analysis and generation of additional digital data:

- Analysis of channel status and user data. The data are output in binary form, as hexadecimal numbers, as ASCII characters or, in the case of channel status data, evaluated in the professional or consumer format to AES 3 or IEC 958 (Fig. 12).

- Generation of channel status data, user data and validity bits. Channel status data can be entered in binary form or via panel to AES 3 or IEC 958 in the professional or consumer format.
- Any bits can be combined under a symbolic name. In this way, data input and representation can easily be adapted to customer's requirements.
- Simultaneous measurement of clock rate and display of interface errors (such as parity error).

Jitter and interface tests (option UPL-B22)

With this option, the physical parameters of digital audio interfaces can be examined. UPL-B22 extends the functions of option UPL-B2.

Signal analysis:

- Measurement of jitter amplitude and display of jitter signal in the frequency and time domain (Figs 9 and 10).
- UPL generates bit- or word-synchronous sync signals that allow the accurate display of digital audio signals on an oscilloscope (preamble, eye pattern, signal symmetry, superimposed noise, etc).
- Measurement of input pulse amplitude and sampling frequency.
- Measurement of phase difference between audio and reference input signal.

Digital components of various data formats and clock rates are the stock-in-trade of professional users. They call for a measuring instrument offering top performance at all interfaces at high accuracy and over a wide dynamic range. Operation is identical for analog and digital interfaces, which enhances operator convenience. Fast fault diagnosis is possible by means of stored test routines, allowing the elimination of problems immediately before transmission.

- Measurement of time difference between output and input signal. This allows delay times of equalizers, audio mixers etc to be measured.
- Analysis of common-mode signal of balanced input (frequency, amplitude, spectrum).

Signal generation:

- The clock of the output signal can be "jittered" by superimposing a sinewave or noise signal of variable amplitude.
- An input signal with jitter can be output jitter-free.
- A common-mode signal can be superimposed on the balanced output signal.
- Long cables can be simulated by means of a switchable cable simulator.
- The phase shift between the digital audio and the reference output can be varied.

Test assemblies for electroacoustic converters frequently consist of microphones and loudspeakers, whose frequency response must be compensated. The equalizer function of UPL furnishes tailor-made solutions for such tests. Comprehensive test routines can be implemented with the aid of the universal sequence controller (page 13).

Designed for convenience

Efficient online help

UPL offers a variety of help functions to provide optimum support for the user:

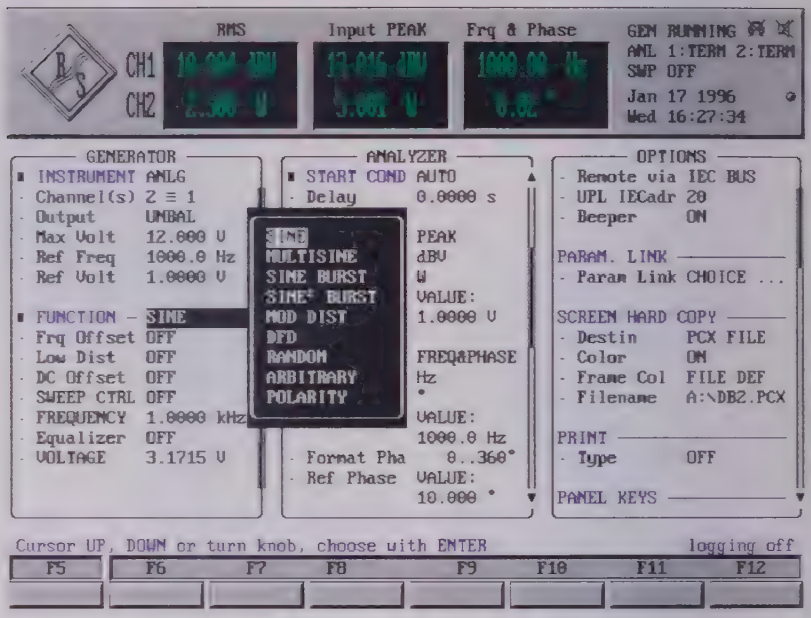
HELP function
HELP information can be called for each input field.

SHOW I/O key
If no results are displayed, eg because no input signal or an incorrect input signal is present, information on possible causes will appear upon pressing SHOW I/O. Moreover, the input and output configuration will be displayed.

Info boxes
These highlighted boxes inform the user of any incorrect settings.

Online help
The permissible range of values is indicated for each menu item requiring the entry of a numerical value. This range takes into account any limitations resulting from higher-order parameters, eg the sample rate in the case of measurements on digital interfaces.

Protection against illegal entries
UPL will not accept entries outside the permissible range. An alarm tone will be issued, and the value changed to the permissible minimum or maximum value.

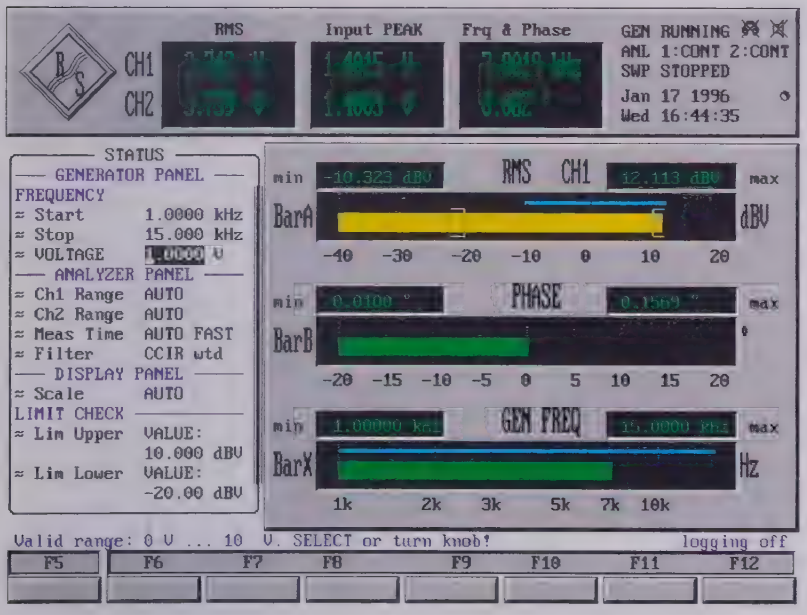


A wealth of functions - yet easy to operate

- Related functions and settings are combined in panels that can be called at a keystroke. Up to three panels can be displayed at a time.
- The operator is not burdened with unnecessary information. Only the parameters and settings needed for a given application are displayed – the others are available in the background. For example, the sweep parameters are transferred to the generator panel and displayed only when the sweep function is activated.
- Uncomplicated entries: the user simply needs to open a menu and make entry or selection.
- Continuous status information on generator, analyzer and sweep.
- Rapid operating sequences through the use of softkeys, eg for graphical representations.
- The user can choose between operation via mouse, external keyboard or front panel. This choice makes sense since the working space required by a mouse is not always available.
- Short learning time thanks to an easy-to-understand operating concept treating analog and digital measurements in the same way.

Results at a glance

- Real-time display of results for one or both channels and several test functions.
- Simultaneous display of frequency and phase.
- With graphics, results can be read off with vertical and horizontal cursors. Tolerance curves or stored results can be added for comparison.
- Sets of traces can be displayed, stored and evaluated for both channels.
- Graphics modes range from traces and bargraphs through spectrum display to three-dimensional waterfalls.



It is often the case that only a few parameters need to be modified after a measurement sequence has been started. Therefore, entry lines can be selected from the input panels for the generator, analyzer, etc by marking them with a tick and transferred to a status panel. The status panel thus provides a summary of parameters for a measurement routine which offers the following advantages:

- Instrument settings can be displayed together with graphical and numerical results.
- All important information can be printed on a single hardcopy.
- Instrument settings can be modified quickly without changing panels as UPL can also be operated from the status panel.

All-in package

Audio Analyzer UPL is a compact unit with an integrated controller. It avoids the disadvantages of external PC control, which is found in other audio analyzers.

UPL features elaborate screening which will not be found in any conventional PC, including magnetically shielded power transformers and coated filter pane in front of the display.

- Built-in hard disk and disk drive.
- Connectors for keyboard, mouse, monitor, printer and plotter.
- Centronics interface for connecting printer or network.
- Drivers for all commercial printers supplied as standard.
- Remote control via IEC/IEEE bus or RS-232-C interface.
- Postprocessing of results directly in UPL using standard software.
- All results available in the common data formats, making it easy to import graphics into documents, for example.
- Easy loading of function and software extensions via floppy disk.
- Automatic test sequences and measurement programs with universal sequence controller. Easy generation of programs with built-in program generator.

The strengths of UPL show up especially in mobile use. The unit is compact and lightweight and requires no additional equipment. Results are stored in the built-in PC and thus available for later use. Routine measurements can be repeated easily using stored instrument settings.

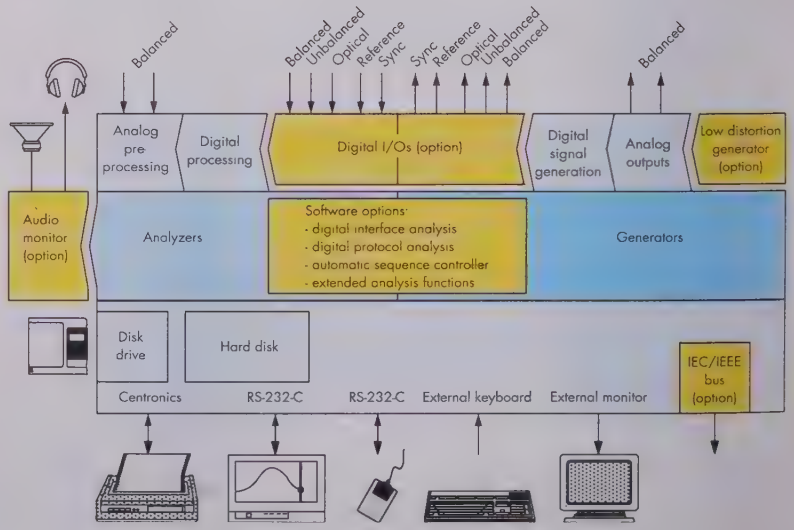
The instrument is easy to transport as it requires no external equipment such as keyboard, monitor or other PC peripherals.

UPL is supplied all ready to the customer. Installation is reduced to unpacking the unit and switching it on for starting the measurement. The user can forget about problems that cropped up in the past with the installation of interface cards or PC software.

With audio analyzers controlled from an external PC, interference may be radiated from the PC, monitor or interface connections, which distorts measurement results. Not so with UPL: the instrument has specified EMC characteristics which also include the internal PC.

And a real boon: the price of UPL includes the internal PC.

Block diagram of UPL



The options

Low Distortion Generator UPL-B1
The low distortion generator is essential for all applications requiring extremely pure analog signals or an extended frequency range up to 110 kHz. Its inherent distortion is well below that of the built-in universal generator which already has excellent specifications.

Digital Interface UPL-B2
contains the digital audio interfaces (balanced, unbalanced and optical). This option is described in detail on pages 8 and 9, including software extensions (protocol analysis and generation, UPL-B21, and jitter and interface test, UPL-B22).

Remote Control UPL-B4
enables remote control of UPL via the RS-232-C interface or the IEC/IEEE-bus interface to IEC625/IEEE 488. The commands implemented largely correspond to SCPI guidelines.

Audio Monitor UPL-B5
adds a headphones output and built-in loudspeaker to UPL. The input signal of the analog and digital interfaces and – with level and THD+N measurements – the filtered or weighted signal can be monitored.

Extended Analysis Functions UPL-B6
In modern audio systems, the transfer characteristics are dynamically adapted to the input signals. With conventional, static test signals as input signals, the dynamic processes are not activated and can thus not be analyzed. *Coherence and transfer functions* are the solution to this problem: speech, music, noise, etc are used as test signals, and the transfer characteristic is represented by analyzing the output spectrum referred to the input spectrum.

Special tests are required in the development and production of hearing aids. No problem for UPL (see also Data Sheet PD 757.2696 "Measurements on hearing aids to IEC118, ANSIS3.22 and S3.42").

With the *rub & buzz measurement*, manufacturing defects of loudspeakers are detected in next to no time by measuring the unwanted signals in the frequency range above that of typical distortion products.

In multitone signal generation, UPL-B6 allows the phase and crest factor to be set.

Further functional extensions of UPL-B6 are under preparation.

Hearing Aids Test Accessories UPL-B7
This option includes an acoustic test chamber as well as all accessories required for measurements on hearing aids such as battery adapters, connecting cables and an acoustic coupler. The associated software enables the complete measurements to EN 60118 and ANSI3.22 (for this, options UPL-B5 and -B10 must be fitted).

Universal Sequence Controller UPL-B10
enables measurement sequences to be generated and executed, thus turning UPL into an automatic test system. Programming of measurement sequences is greatly facilitated by the built-in program generator:

Each manual control step is recorded in the logging mode and translated into a complete line of the sequence program with correct syntax, ie test sequences can be programmed without a single line to be typed by the user. The program thus generated does not just give the sequence of keys to be pressed but contains the instructions in easy-to-read IEC/IEEE-bus syntax according to SCPI. BASIC commands can then be used to modify the program, eg for branching or graphic outputs.

Complete application programs based on the universal sequence controller are available for measurements on CD players, tuners, etc.

The universal sequence controller can also be used for remote control of external equipment via the IEC/IEEE-bus or the RS-232-C interface. On the other hand, programs generated on UPL can after slight modifications be transferred to an external controller for the remote control of UPL. This greatly facilitates the generation of remote-control programs.

150 Ω Modification UPL-U3
changes the source impedance of the analog generator from 200 Ω to 150 Ω.

Specifications

Data without tolerances are typical values

Analog analyzers

For analog measurements two analyzers with different bandwidths, specifications and measurement functions are provided.

Analyzer	Frequency range
ANLG 22 kHz	DC/10 Hz to 21,90 kHz *)
ANLG 110 kHz	DC/20 Hz to 110 kHz *)
Level measurements (rms)	
Error limit at 1 kHz	±0.05 dB
Frequency response ref. to 1 kHz	
20 Hz to 22 kHz	±0.03 dB
10 to 20Hz	±0.1 dB
22 to 50 kHz	±0.1 dB
50 to 110 kHz	±0.2 dB

*) DC/AC coupling

Inputs

XLR connectors	2 channels, balanced (unbalanced measurements possible with XLR/BNC Adapter UPL-Z1), floating/grounded and AC/DC coupling switchable
Voltage range	0.1 µV to 110 V_{rms} (sine)
Measurement range	18 mV to 100 V, in steps of 5 dB
Input impedance	100 kΩ ±1% shunted with 120 pF, each pin against ground
	300 Ω, 600 Ω, ±0.5% each, P_{max} 1W
Crosstalk attenuation	>120 dB, frequency <22 kHz, 600 Ω
Common-mode rejection (V_{in} <3 V)	>100 dB at 50 Hz, >86 dB at 1 kHz, >80 dB at 16 kHz
Generator output	each input channel switchable to the other output channel, input impedance: balanced 200 kΩ, unbalanced 100 kΩ

Measurement functions

RMS value, wideband	
Error limits	
Measurement speed	
AUTO	±0.05 dB at 1 kHz, sine
AUTO FAST	±0.1 dB additional error
Integration time	
AUTO FAST/AUTO	4.2 ms/42 ms, at least 1 cycle
VALUE	1 ms to 10 s
GEN TRACK	2.1 ms, at least 1 cycle
Noise (600 Ω)	
with A filter	1 µV
with CCIR unweighting filter	<2 µV, 1.6 µV typ. (ANLG 22 kHz)
Filters	weighting filters and user-definable filters, up to 3 filters can be combined, analog notch filter in addition (expansion of dynamic range by up to 30 dB)
Spectrum	post-FFT of filtered signal
RMS value, selective	
Bandwidth (–0.1 dB)	1%, 3%, 1/12 octave, 1/3 octave and user-selectable fixed bandwidth, minimum bandwidth 10 Hz
Selectivity	100 dB (80 dB) with analyzer ANLG 22 kHz (110 kHz), bandpass or bandstop filter, 8th-order elliptical filter, analog notch filter in addition
Frequency setting	– automatic to input signal – coupled to generator – fixed through entered value – sweep through selectable range
Error limit	±0.2 dB + ripple of filters
Peak value	with analyzer ANLG 22 kHz only
Measurement	peak max., peak min., peak-to-peak, peak absolute
Error limit	±0.2 dB at 1 kHz
Interval	20 ms to 10 s
Filters	weighting filters and user-definable filters, up to 3 filters can be combined
Quasi-peak	with analyzer ANLG 22 kHz only
Measurement, error limits	to CCIR 468-4
Noise (600 Ω)	<8 µV with CCIR weighting filter,
Filters	weighting filters and user-definable filters, up to 3 filters can be combined, analog notch filter in addition
DC voltage	
Voltage range	0 to ±110 V
Error limit	±(1% of measured value + 0.1% of measurement range)
Measurement range	100 mV to 100 V, in steps of 10 dB
S/N measurement routine	available for measurement functions – rms, wideband – peak – quasi-peak indication of S/N ratio in dB, no post-FFT
FFT analysis	see FFT analyzer section

Total harmonic distortion (THD)		
Fundamental		10 Hz to 22 kHz
Frequency tuning		automatic to input or generator signal or fixed through entered value
Weighted harmonics		any combination of d_2 to d_9, up to 110 kHz
Error limits		
harmonics		
<50 kHz		±0.5 dB
<110 kHz		±0.7 dB
Inherent distortion*)		
Analyzer ANLG 22 kHz		
Fundamental	20 Hz to 10.95 kHz	<–110 dB, typ. –115 dB
	10 to 20 Hz	<–100 dB
Analyzer ANLG 110 kHz		
Fundamental	50 Hz to 20 kHz	<–100 dB, typ. –105 dB
Spectrum		bar chart showing signal and distortion

*) Total inherent distortion of analyzer and generator (with option UPL-B1), analyzer with dynamic mode precision.
>3.5 V: typ. reduced by 3 dB; <0.5 V: sensitivity reduced by input noise (typ. 0.25/1.25 µV for analyzers 22/110 kHz).

THD+N and SINAD		
Fundamental		10 Hz to 22 kHz
Frequency tuning		automatic to input or generator signal or fixed through entered value
Input voltage		>100 µV typ. with automatic tuning
Bandwidth		upper and lower frequency limit selectable, one weighting filter in addition
Error limits		
Bandwidth	<50 kHz	±0.5 dB
	<100 kHz	±0.7 dB
Inherent distortion*)		
Analyzer ANLG 22 kHz		
Bandwidth	20 Hz to 21.90 kHz	typ. –110 dB at 1 kHz, 2.5 V
		<–105 dB +2 µV **)
		typ. –108 dB +1.5 µV
Analyzer ANLG 110 kHz		
Bandwidth	20 Hz to 22 kHz	<–95 dB + 2.5 µV
		typ. –100 dB +1.75 µV
	20 Hz to 110 kHz	<–88 dB + 5 µV
		typ. –95 dB + 3.5 µV
Spectrum		post-FFT of filtered signal

*) Total inherent distortion of analyzer and generator (with option UPL-B1), analyzer with dynamic mode precision.
**) For full measurement range (<–100 dB + 2 µV with auto range function). <–100 dB for input voltage >3.5 V.

Modulation factor (MOD DIST)		
Measurement method		selective to DIN IEC 268-3
Frequency range,	lower frequency	30 to 2700 Hz
	upper frequency	8xLF to 100 kHz*)
Error limit		±0.50 dB
Inherent distortion**)		
Upper frequency	4 to 15 kHz	<–96 dB (–90 dB), typ. –103 dB
	15 to 20 kHz	<–96 dB (–85 dB)
Spectrum		bar chart showing signal and distortion

*) For upper frequency >20 kHz the bottom limit of lower frequency is reduced.
**) Input voltage >200 mV, typical values apply to 0.5 to 3.5 V.
Lower frequency >200 Hz, values in ( ) for lower frequency <200 Hz.
Dynamic mode precision; level ratio LF:UF = 4:1.

Difference frequency distortion (DFD)

Measurement method		selective to DIN IEC 268-3 or 118
Frequency range		
difference frequency		80 Hz to 2 kHz
center frequency		200 Hz to 100 kHz*)
Error limit		±0.50 dB, center frequency <20 kHz
Inherent distortion**)	DFD d_2	<–112 dB, typ. –125 dB
	DFD d_3	<–96 dB, typ. –105 dB
Spectrum		bar chart showing signal and distortion

*) For center frequency >20 kHz the bottom limit of the difference frequency is reduced.
**) Input voltage >200 mV, typical values apply to 0.5 to 3.5 V, dynamic mode precision (at DFD d_2), center frequency 7 to 20 kHz.

Wow and flutter		with analyzer ANLG 22 kHz only
Measurement method		DIN/IEC, NAB, JIS, 2-sigma to IEC-386
Weighting filter	OFF	highpass 0.5 Hz, bandwidth 200 Hz
	ON	bandpass 4 Hz to IEC-386
Error limit		±3%
Inherent noise		<0.0005% weighted
		<0.001% unweighted
Spectrum		post-FFT of demodulated signal

Time domain display (WAVEFORM)

Trigger	rising/falling edge
Trigger level	–200 to +200 V, interpolated between samples
Trace length	max. 7424 points
Standard mode	1- to 32-fold interpolation
Compressed mode	2- to 1024-fold compression (envelope for AGC measurement), with analyzer ANLG 22 kHz only

Frequency *)

Frequency range	20 Hz to 110 kHz
Error limit	±50 ppm

Phase *)

	with analyzer 22 kHz only
Frequency range	20 Hz to 20 kHz
Error limit	±0.5°

Group delay*)

	with analyzer 22 kHz only
Frequency range	20 Hz to 20 kHz
Measurement error in seconds	$\Delta\varphi/(\Delta f \cdot 360)$ **)

*) Only for measurement functions RMS, FFT and THD+N, error limits apply to 8k FFT with zoom factor 2, Rife-Vincent-2 window; S/N ratio >70 dB.
**) $\Delta\varphi$ = phase measurement error in °, Δf = frequency step.

Polarity test

Measurement	polarity of unsymmetrical input signal
Display	+POL, –POL

Analog generators

An 18-bit ΔΣ D/A converter is used for analog signal generation. The characteristics of the basic generator can be improved and extended with a low-distortion RC oscillator (Low Distortion Generator UPL-B1):
– sine with reduced distortion
– frequency range up to 110 kHz

Outputs

XLR connectors, 2 channels, floating, balanced/unbalanced switchable, short-circuit-proof; max. current <120 mA with external feed

Balanced

Voltage	0.1 mV to 20 V_{rms} (sine, open-circuit)
Crosstalk attenuation	>115 dB, frequency <20 kHz
Source impedance	typ. 10 Ω, 200 Ω (150 Ω with UPL-U3) ±0.5%, 600 Ω ±0.5%
Load impedance	>400 Ω (incl. source impedance)
Output balance	>75 dB at 1 kHz, >60 dB at 20 kHz

Unbalanced

Voltage	0.1 mV to 10 V_{rms} (sine, open-circuit)
Crosstalk attenuation	>115 dB, frequency <20 kHz
Source impedance	5 Ω
Load impedance	>200 Ω

Signals

Sine

Frequency range	2 Hz to 21.75 kHz
Frequency error	±50 ppm
Level error	±0.1 dB at 1 kHz
Frequency response (referred to 1 kHz)	
20 Hz to 20 kHz	±0.05 dB
Inherent distortion THD+N	
Measurement bandwidth	
20 Hz to 22 kHz	<–94 dB, typ. –98 dB
20 Hz to 100 kHz	<–86 dB
Sweep parameters	frequency, level

Sine (with low-distortion generator option)

Frequency range		10 Hz to 110 kHz
Frequency error		±0.5% at 15 to 30°C
		±0.75% at 5 to 45°C
Level error		±0.1 dB at 1 kHz
Frequency response (ref. to 1 kHz)		
20 Hz to 20 kHz		±0.05 dB
10 Hz to 110 kHz		±0.1 dB
Harmonics		typ. <–115 dB (<–120 dB at 1 kHz), measurement bandwidth 20 Hz to 20 kHz, voltage 1 to 5 V
Inherent distortion (THD)		
Fundamental	1 kHz, 1 to 10 V	<–120 dB typ.
	20 Hz to 7 kHz	<–105 dB
	7 to 20 kHz	<–100 dB

Inherent distortion (THD+N) *)			Meas. bandw.
Fundamental	1 kHz, 2.5 V	–110 dB typ.	22 kHz
	20 Hz to 20 kHz	<–100 dB +2 µV	22 kHz
	20 Hz to 20 kHz	<–88 dB +5 µV	100 kHz
Sweep parameters		frequency, level	

*) Total inherent distortion of analyzer and generator, analyzer with dynamic mode precision.

MOD DIST

		for measuring the modulation distortion
Frequency range,	lower frequency	30 to 2700 Hz
	upper frequency	8xLF to 21.75 kHz
Level ratio (LF:UF)		from 10:1 to 1:1, selectable
Level error		±0.5 dB
Inherent distortion		<–94 dB (typ. –100 dB) at 7 kHz, 60 Hz
		<–84 dB (typ. –90 dB), level ratio LF:UF = 4:1
Sweep parameters		upper frequency, level

DFD

		for measuring the difference tone
Frequency range,	difference frequency	80 Hz to 2 kHz
	center frequency	200 Hz to 20.75 kHz
Level error		±0.5 dB
Inherent distortion*)	DFD d_2	< –114 dB, typ.–120 dB
	DFD d_3	< –92 dB, typ. –100 dB
Sweep parameters		center frequency, level

*) Center frequency >5 kHz, difference frequency <1 kHz; DFD d_2 –100 dB (typ.) with DC offset.

Multi-sine

Frequency range	2.93 Hz to 21.75 kHz
Frequency spacing	adjustable from 2.93 Hz
Frequency resolution	<0.01% or matching FFT frequency spacing
Dynamic range	100 dB, referred to total peak value
Characteristics	
Mode 1	1 to 17 spectral lines – level and frequency selectable for each line – phase of each component optimized for minimum crest factor – phase of each component or crest factor selectable (with UPL-B6)
Mode 2	1 to 7400 spectral lines (noise in frequency domain), distribution: white, pink, 1/3 octave, defined by file; crest factor selectable (with UPL-B6)

Sine burst, sine² burst

Burst time	1 sample up to 60 s, 1-sample resolution
Interval	burst time up to 60 s, 1-sample resolution
Low level	0 to burst level, absolute or relative to burst level (0 with sine² burst)
Bandwidth	21.75 kHz (elliptical filter)
Sweep parameters	burst frequency, level, time, interval

Noise

Distribution	Gaussian, triangular, rectangular

Arbitrary waveform

	loaded from file
Memory size	max. 16 k
Clock rate	48 kHz
Bandwidth	21.75 kHz (elliptical filter)

Polarity test signal

Sine² burst with following characteristics:

Frequency	1.2 kHz
On-time	1 cycle (0.8333 ms)
Interval	2 cycles (1.6667 ms)

DC offset*)	0 to ±10.0 V (±5 V unbalanced)
Error	±2%
Residual offset	<1% of rms value of AC signal

*) No DC offset for signal generation with Low Dist ON.
With DC offset the AC voltage swing will be reduced; specified inherent distortion values apply to DC offset = 0.

Digital analyzer (with option UPL-B2)

Frequency limits specified for measurement functions apply to a sampling rate of 48 kHz. For other sampling rates limits are calculated according to the formula: $f_{new} = f_{48\ kHz}$ · sampling rate/48 kHz.

Inputs

Balanced input	XLR connector, transformer coupling
Impedance	110 Ω
Level (V_{pp})	min. 200 mV, max. 12 V
Unbalanced input	BNC, grounded
Impedance	75 Ω
Level (V_{pp})	min. 100 mV, max. 5 V
Optical input	TOSLINK
Channels	1, 2, or both
Audio bits	8 to 24
Clock rate	27 to 55 kHz, synchronous to DAI or DARS
Format	professional and consumer format to IEC-958 as well as user-definable formats at all inputs

Measurement functions

(all measurements at 24 bits, full scale)

RMS value, wideband

Measurement bandwidth	up to 0.5 times the clock rate
Error limits	
AUTO FAST	±0.1 dB
AUTO	±0.01 dB
FIX	±0.001 dB
Integration time	
AUTO FAST/AUTO	4.2 ms/42 ms, at least 1 cycle
VALUE	1 ms to 10 s
GEN TRACK	2.1 ms, at least 1 cycle
Filters	weighting filters and user-definable filters, up to 3 filters can be combined
Spectrum	post-FFT of filtered signal

RMS value, selective

Bandwidth (–0.1 dB)	1%, 3%, 1/12 octave, 1/3 octave and user-selectable fixed bandwidth, min. bandwidth 10 Hz
Selectivity	100 dB, bandpass or bandstop filter, 8th-order elliptical filter
Frequency setting	– automatic to input signal – coupled to generator – fixed through entered value – sweep through selectable range
Error limit	±0.2 dB + ripple of filters

Peak value

Measurement	peak max., peak min., peak-to-peak, peak absolute
Error limit	±0.2 dB at 1 kHz
Interval	20 ms to 10 s
Filters	weighting filters and user-definable filters, up to 3 filters can be combined

Quasi-peak

Measurement, error limits	to CCIR 468-4
Filters	weighting filters and user-definable filters, up to 3 filters can be combined

DC voltage

Measurement range	0 to ±FS
Error limit	±1%

S/N measurement routine

available for measurement functions:
– rms, wideband
– peak
– quasi-peak
indication of S/N ratio in dB, no post-FFT

FFT analysis

see FFT analyzer section

Total harmonic distortion (THD)

Fundamental		10 Hz to 21.90 kHz
Frequency tuning		automatic to input or generator signal or fixed through entered value
Weighted harmonics		any combination of d_2 to d_9, up to 21.90 kHz
Error limit		±0.1 dB
Inherent distortion [1])		
Fundamental	42 Hz to 21.90 kHz	<–130 dB
	24 to 42 Hz	<–112 dB
	12 to 24 Hz	<–88 dB
Spectrum		bar chart showing signal and distortion

THD+N and SINAD

Fundamental		10 Hz to 21.90 kHz
Frequency tuning		automatic to input or generator signal or fixed through entered value
Stopband range		fundamental ±28 Hz, max. up to 2nd harmonic
Bandwidth		upper and lower frequency limit selectable, one weighting filter in addition
Error limit		±0.3 dB
Inherent distortion [1])		
Bandwidth 20 Hz to 21.90 kHz		
Fundamental	28 Hz to 21.90 kHz	<–126 dB
	24 to 28 Hz	<–109 dB
	20 to 24 Hz	<–96 dB
Spectrum		post-FFT of filtered signal

Modulation distortion (MOD DIST)

Measurement method		selective to DIN-IEC 268-3
Frequency range		
Lower frequency		30 to 2700 Hz [2])
Upper frequency		8xLF [2]) to 21.25 kHz
Error limit		±0.2 dB
Inherent distortion [1])		
Level LF:UF	1:1	<–133 dB
	4:1	<–123 dB
	10:1	<–115 dB
Spectrum		bar chart showing signal and distortion

Difference frequency distortion (DFD)

Measurement method		selective to DIN-IEC 268-3 or 118
Frequency range		
Difference frequency		80 Hz to 2 kHz [2])
Center frequency		200 Hz to 20.90 kHz
Error limit		±0.2 dB
Inherent distortion [1])	DFD d_2	<–130 dB
	DFD d_3	<–130 dB
Spectrum		bar chart showing signal and distortion

Wow and flutter

Measurement method		DIN/IEC, NAB, JIS, 2-sigma to IEC-386
Weighting filter	OFF	highpass 0.5 Hz, bandwidth 200 Hz
	ON	bandpass 4 Hz to IEC-386
Error limit		±3%
Inherent noise		<0.0003% weighted <0.0008% unweighted
Spectrum		post-FFT of demodulated signal

[1]) Total inherent distortion of analyzer and generator.
[2]) Fixed frequency independent of sampling rate.

Time domain display (WAVEFORM)

Trigger	rising/falling edge
Trigger level	–1 FS to +1 FS, interpolated between samples
Trace length	max. 7424 points
Standard mode	1- to 32-fold interpolation
Compressed mode	2- to 1024-fold compression (envelope for AGC measurement)

Frequency *)

Frequency range	20 Hz to 20 kHz
Error limit	±50 ppm

Phase *)

Frequency range	20 Hz to 20 kHz
Error limit	±0.5°

Group delay *)

Frequency range	20 Hz to 20 kHz
Measurement error in seconds	$\Delta\varphi/(\Delta f \cdot 360)$ **)

*) Only for measurement functions RMS, FFT and THD+N, error limits apply to 8k FFT with zoom factor 2, Rife-Vincent-2 window; S/N ratio >70 dB.

**) $\Delta\varphi$ = phase measurement error in °, Δf = frequency step.

Polarity test

Measurement	polarity of unsymmetrical input signal
Display	+POL, –POL

Digital generator (with option UPL-B2)

Frequency limits specified for the signals apply to a sampling rate of 48 kHz. For other sampling rates limits are calculated according to the formula: $f_{new} = f_{48\,kHz}$ · sampling rate/48 kHz.

Outputs

Balanced output	XLR connector, transformer coupling
Impedance	110 Ω, short-circuit-proof
Level (V_{pp} into 110 Ω)	0 to 8 V, in 240 steps
Error limit	±1 dB_{rms}
Unbalanced output	BNC, transformer coupling
Impedance	75 Ω, short-circuit-proof
Level (V_{pp} into 75 Ω)	0 to 2 V, in 240 steps
Error limit	±1 dB_{rms}
Optical output	TOSLINK
Channels	1, 2, or both
Audio bits	8 to 24
Clock rate	internal: 27 to 55 kHz or synchronization to analyzer external: synchronization to wordclock input, video sync, DARS, 1024 kHz
Format	professional and consumer format to IEC-958 as well as user-definable formats at all outputs

Signals

(all signals with 24 bits, full scale)

General characteristics

Level resolution	2^{-24}
Audio bits	8 to 24 bits, LSB rounded off
Dither*)	
Distribution	Gaussian, triangular, rectangular
Level	2^{-24} FS to 1 FS
Frequency error	±50 ppm (internal clock), ±1 ppm relative to clock rate
Frequency offset*)	0 or +1000 ppm
DC offset	0 to ±1 FS adjustable

*) With sine, DFD and MOD DIST signals.

Sine

Frequency range	2 Hz[2]) to 21.90 kHz
Total harmonic distortion (THD)	<–133 dB
Sweep parameters	frequency, level

MOD DIST for measuring the modulation distortion

Frequency range	
Lower frequency	30[2]) to 2700 Hz[2])
Upper frequency	8xLF[2]) to 21.90 kHz
Level ratio (LF:UF)	from 10:1 to 1:1, selectable
Inherent distortion[1])	
Level LF:UF 1:1	<–133 dB
4:1	<–123 dB
10:1	<–115 dB
Sweep parameters	upper frequency, level

DFD for measuring the difference tone

Frequency range	
Difference frequency	80 Hz to 2 kHz[2])
Center frequency	200 Hz[2]) to 20.90 kHz
Inherent distortion	
DFD d_2	<–130 dB
DFD d_3	<–130 dB
Sweep parameters	center frequency, level

Multi-sine

Frequency range	2.93 Hz to 21.90 kHz
Frequency spacing	adjustable from 2.93 Hz
Frequency resolution	<0.01% or matching FFT frequency spacing
Dynamic range	>133 dB
Characteristics	
Mode 1	1 to 17 spectral lines – level and frequency selectable for each line – phase of each component optimized for minimum crest factor – phase of each component or crest factor selectable (with UPL-B6)
Mode 2	1 to 7400 spectral lines (noise in frequency domain), distribution: white, pink, 1/3 octave, defined by file; crest factor selectable (with UPL-B6)

Sine burst, sine[2] burst

Burst time	1 sample up to 60 s, 1-sample resolution
Interval	burst time up to 60 s, 1-sample resolution
Low level	0 to burst level, absolute or referred to burst level (0 for sine[2] burst)
Sweep parameters	burst frequency, level, time, interval

Noise

Distribution	Gaussian, triangular, rectangular

Arbitrary waveform

Memory size	loaded from file
Clock rate	max. 16k sampling rate of generator

Polarity test signal

Sine[2] burst with the following characteristics:	
Frequency	1.2 kHz[2])
On-time	1 cycle
Interval	2 cycles

Digital audio protocol (option UPL-B21)

Generator

Validity bit	NONE, L, R, L+R
Channel status data	mnemonic entry with user-definable masks, predefined masks for professional and consumer format to IEC 958
User data	loaded from file (max. 384 bits) or set to zero

Analyzer

Display	validity bit L and R
Error indication	block errors, sequence errors, clock rate errors, preamble errors
Clock rate measurement	50 ppm
Channel status display	user-definable mnemonic display of data fields, predefined settings for professional and consumer format to IEC 958, binary and hexadecimal format
User-bit display	user-definable mnemonic display, block-synchronized

1) Total inherent distortion of analyzer and generator.

2) Fixed frequency independent of sampling rate.

Jitter and interface test (option UPL-B22)

Generator

Jitter injection	
Signal shape	sine, noise
Frequency range	10 Hz to 21.75 kHz (sine to 110 kHz with option UPL-B1)
Amplitude (peak-to-peak)	0 to 5 UI (corresp. to 0 to 800 ns at 48 kHz sampling rate)
Common mode signal	for balanced output
Waveform	sine
Frequency range	20 Hz to 21.75 kHz (110 kHz with option UPL-B1)
Amplitude (V_{pp})	0 to 20 V
Phase (output to reference)	adjustable between –64 and +64 UI (corresp. to ±50% of frame)
Cable simulator	100 m typical audio cable

Analyzer

Input signal	
Amplitude (V_{pp})	0 to 10 V
Sampling rate	27 to 55 kHz
Jitter measurement	amplitude, frequency, spectrum 0 to 5 UI typ. for f <500 Hz, decreasing to 0.5 UI for f up to 50 kHz
Measurement limit	200 ps (noise floor with 8k FFT)
Reclocking	input signal is sampled with a low-jitter clock signal and available at reference output (XLR connector on the rear)
Common mode test	on balanced input
Amplitude (V_{pp})	0 to 30 V
Frequency, spectrum	20 Hz to 110 kHz
Phase (input to reference)	–64 to +64 UI (corresp. to ±50% of frame)
Delay (input to output)	100 µs to 500 ms

FFT analyzer

Specifications apply to analyzer ANLG 22 kHz or digital analyzer; values in ( ) apply to analyzer ANLG 110 kHz.

Frequency range	DC to 21.9 kHz (110 kHz)
Dynamic range	
Digital	>135 dB
ANLG 22 kHz	120 dB/105 dB (with/without analog notch filter)
ANLG 110 kHz	115 dB/85 dB (with/without analog notch filter)
Noise floor	
Digital	–160 dB
ANLG 22 kHz	–140 dB/110 dB (with/without analog notch filter)
ANLG 110 kHz	–120 dB/90 dB (with/without analog notch filter)
FFT size	256, 512, 1 k, 2 k, 4 k, 8 k points (16 k with zoom factor 2)
Window functions	rectangular, Hann, Blackman-Harris, Rife-Vincent 1 to 3, Hamming, flat top, Kaiser (β = 1 to 20)
Resolution	from 0.05 Hz with zoom, from 5.86 Hz without zoom
Zoom	2 to 128 (2 to 16)
Averaging	1 to 256, exponential and normal

Filters

For all analog and digital analyzers. Up to 3 filters can be combined as required. All filters are digital filters with a coefficient accuracy of 32 bit floating point (exception: analog notch filter).

Weighting filters

- A weighting
- C message
- CCITT
- CCIR weighted, unweighted
- CCIR ARM
- deemphasis 50/15, 50, 75, J.17
- rumble weighted, unweighted
- DC noise highpass filter
- IEC/IEEE tuner
- Jitter weighted

User-definable filters

Design parameters:
8th order elliptical, type C (for highpass and lowpass filters also 4th order), passband ripple +0/–0.1 dB, stopband attenuation approx. 20 to 120 dB selectable in steps of approx. 10 dB (highpass and lowpass filters: stopband attenuation 40 to 120 dB).

Highpass, lowpass filters	limit frequencies (–0.1 dB) selectable, stopband indicated
Bandpass, bandstop filters	passband (–0.1 dB) selectable, stopband indicated
Notch filter	center frequency and width (–0.1 dB) selectable, stopband indicated
One-third and octave filters	center frequency selectable, bandwidth (–0.1 dB) indicated
File-defined filters	any 8th-order filter cascaded from 4 biquads, defined in the z plane by poles/zeroes or coefficients

Analog notch filter

For measurements on signals with high S/N ratio, this filter improves the dynamic range of the analyzer by up to 30 dB to 140 dB for analyzer 22 kHz, or 120 dB for analyzer 110 kHz (typical noise floor of FFT). The filter is also used for measuring THD, THD+N and MOD DIST with dynamic mode precision.

Characteristics	available in analog analyzers with measurement functions: – rms, wideband – rms, selective – quasi-peak – FFT analysis
Frequency range	10 Hz to 22.5 kHz center frequency (f_c)
Frequency tuning	– automatic to input signal – coupled to generator – fixed through entered value
Stopband range	typ. >30 dB, f_c ±0.5%
Passband range	typ. –3 dB at 0.77 · f_c and 1.3 · f_c, typ. +0/–1 dB outside 0.5 · f_c to 2 · f_c

Sweep

Generator sweep

Parameters	frequency, level, with bursts also interval and duration, one- or two-dimensional
Sweep	linear, logarithmic, tabular, single, continuous, manual
Stepping	– automatic after end of measurement – time delay (fixed or loaded table)

Analyzer sweep

Parameters	frequency or level of input signal
Sweep	single, continuous
Trigger	– delayed (0 to 10 s) after input level or input frequency variation, settling function selectable – time-controlled
Settling	for level, frequency, phase, distortion measurements, settling function: exponential, flat or averaging

Sweep speed

Two-channel rms measurement 20 Hz to 20 kHz, 30-point generator sweep, logarithmic (frequency measurement switched off, Low Dist off).

with	GEN TRACK	0.5 s
	AUTO FAST	1 s
	AUTO	2.5 s

Display of results

Units	
Level (analog)	V, dBu, dBV, W, dBm, difference (Δ), deviation (Δ%) and ratio (without dimension, %, dBr), to reference value
Level (digital)	FS, %FS, dBFS, LSBs deviation (Δ%) or ratio (dBr), to reference value
Distortion	% or dB, referred to signal amplitude, THD and THD+N in all available level units (absolute or relative to selectable reference value)
Frequency	Hz, difference (Δ), deviation (Δ%) and ratio (as quotient f/f_{ref}, 1/3 octave, octave or decade), to reference value (entered or stored, current generator frequency)
Phase	°, rad, difference (Δ), to reference value (entered or stored)

Reference value (level):
Fixed value (entered or stored).
Current value of a channel or generator signal, permits direct measurement of gain, linearity, channel difference, crosstalk. In sweep mode, traces (other trace or loaded from file) can be used as a reference too.

Graphical display of results	
Monitor (UPL model 06)	9", LCD (TFT), colour
Display modes	– display of any sweep – display of trace groups – bargraph display with min./max. values – spectrum, also as waterfall display – lists of results – bar charts for THD and intermodulation measurements
Display functions	– autoscale – X-axis zoom – full-screen and part-screen mode – 2 vertical, 1 horizontal cursor line – search function for max. values – marker for harmonics (spectrum) – user-labelling for graphs – change of unit and scale also possible for loaded traces
Test reports	
Functions	– screen copy to printer, plotter or file (PCX, HPGL, Postscript) – lists of results – sweep lists – tolerance curves – list of out-of-tolerance values – equalizer traces
Printer driver	supplied for approx. 130 printers
Plotter language	HP GL
Interfaces	2 x RS-232-C, Centronics, IEC 625 (option UPL-B4)
Storage functions	– instrument settings, optionally with measured values and curves – spectra – sweep results – sweep lists – tolerance curves – equalizer traces
Remote control	via IEC 625-2 (IEEE 488) and RS-232-C; commands largely to SCPI (option UPL-B4)

Audio monitor (option UPL-B5)

Headphone connector	6.3-mm jack socket
Output voltage	max. 8 V_p
Output current	max. 50 mA_p
Source impedance	10 Ω, short-circuit-proof
Recommended headphone impedance	600 Ω

Extended analysis functions (option UPL-B6)

Coherence and transfer functions	can be displayed simultaneously
Frequency range	DC to 21.9 kHz
Frequency resolution	from 5.86 Hz
Averaging	2 to 1024
FFT length	256, 512, 1 k, 2 k, 4 k, 8 k points
Rub & buzz measurement	simultaneous measurement of frequency response, rub & buzz and polarity
Frequency range	10 Hz to 110 kHz
Tracking highpass filter	2 to 20 times fundamental
Lower/upper frequency limit	selectable
Measurement time (200 Hz to 20 kHz, 200 points log.)	2 s
Multisine generator function	extended functions
Mode 1	crest factor or phase of each component selectable
Mode 2	crest factor selectable
Further functions	being developed

Hearing aids test accessories (option UPL-B7)

Consisting of	acoustic test chamber, acoustic 2 cm^3 coupler, various battery adapters, connecting cables, software for measurements to 60118 and ANSI 3.22
Additional requirements	options UPL-B5 and UPL-B10

150 Ω modification (option UPL-U3)

Change of source impedance of analog generator to 150 Ω (instead of 200 Ω set as standard) at the factory

General data

Operating temperature range	0 to +45 °C
Storage temperature range	–20 to +60 °C
Humidity	max. 85% for max. 60 days, below 65% on average/year, no condensation
EMI	EN 50081-1
EMS	EN 50082-1
Safety standards	DIN EN 61010-1, IEC 1010-1, UL 3111-1, CAN/CSA C 22.2 No. 1010-1
Conformity marks	VDE-GS, UL, cUL
Power supply	100/120/220/230 V ±10%, 50 to 60 Hz, 110 VA
Dimensions (W x H x D)	435 mm x 192 mm x 475 mm
Weight	12.6 kg

Ordering information

Order designation		
Audio Analyzer with colour LCD	UPL	1078.2008.06
Audio Analyzer without display and keyboard	UPL66	1078.2008.66
Accessories supplied	power cable, operating manual, backup disks with MS-DOS operating system and user manual, backup program disk with operating and measurement software	
Options		
Low Distortion Generator	UPL-B1	1078.4400.02
Digital Audio I/O	UPL-B2	1078.4000.02
Digital Audio Protocol	UPL-B21	1078.3856.02
Jitter and Interface Test	UPL-B22	1078.3956.02
Remote Control	UPL-B4	1078.3804.02
Audio Monitor	UPL-B5	1078.4600.02
Extended Analysis Functions	UPL-B6	1078.4500.02
Hearing Aids Test Accessories	UPL-B7	1090.2704.02
Universal Sequence Controller	UPL-B10	1078.3904.02
XLR/BNC Adapter Set	UPL-Z1	1078.3704.02
150 Ω Modification	UPL-U3	1078.4900.02
Recommended extras		
19" Rack Adapter	ZZA-94	0396.4905.00
Service manual		1078.2089.24

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Safety Instructions

This unit has been designed and tested according to the standards outlined overleaf and has left the manufacturer's premises in a state fully complying with the safety standards.

In order to maintain this state and to ensure safe operation, observe the following instructions, symbols and precautions.

1) When the unit is to be permanently cabled, first connect protective ground conductor before making any other connections.

2) Built-in units should only be operated when properly fitted into the system.

3) For permanently cabled units without built-in fuses, automatic switches or similar protective facilities, the AC supply line shall be fitted with fuses rated to the units.

4) Before switching on the unit ensure that the operating voltage set at the unit matches the line voltage.

   If a different operating voltage is to be set, use a fuse with appropriate rating.

5) Units of protection class I with disconnectible AC supply cable and plug may only be operated from a power socket with protective ground contact.

   The protective ground connection should not be made ineffective by an extension cable.

   Any breaking of the protective ground conductor within or outside of the unit or loosening of the protective ground connection may cause the unit to become electrically hazardous.

   The protective ground conductor shall not be interrupted intentionally.

6) Before opening the unit, isolate it from the AC supply.

   Adjustment and replacement of parts as well as maintenance and repair should be carried out only by specialists approved by R & S.

   Observe safety regulations and rules for the prevention of accidents.

   Use only original parts for replacing parts relevant to safety (e.g. power on/off switches, power transformers or fuses).

7) Also observe the additional safety instructions specified in this manual.

Explanation of Symbols Used

- Read operating manual, observe the safety symbols used

- Caution, shock hazard

- Protective ground connection

- Unit ground

-Equipotentiality

- Ground

EMC Recommendations

The electromagnetic compatibility of the UPI complies with the relevant standards specified in the data sheet.
Please observe the following to obtain accurate measurements in the presence of electromagnetic disturbances:

- Use shielded cables to all connectors of the UPL (both measurement inputs/outputs and computer links to eg the printer).
- The balanced inputs/outputs are much less susceptible to interference fields than the unbalanced ones and should therefore be used in the relevant cases.
- For connection of an external monitor, we recommend the use of a low-radiation model.
- When operating the UPD with an external keyboard, the Rohde & Schwarz keyboard which is protected against radiated noise should be employed.

ESD Recommendations

The unit cannot offer absolute protection against electrostatic discharge at the generator and test connectors due to critical parameters such as high input sensitivity, low intrinsic distortion, high unbalance rejection and also because of the floating generator and test inputs. The unit is ressistant to ESD up to approx. ± 4 kV. In sensitive environments, eg highly isolating floor coverings or clothing and shoes of operators, it is recommended to take the relevant ESD protective measures before contacting the floating built-in connectors.

Certified Quality System

ISO 9001

DQS REG. NO 1954-04

Qualitätszertifikat

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist nach ISO 9001 zertifiziert.

Certificate of quality

Dear Customer,

You have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards.
The Rohde & Schwarz quality management system is certified according to ISO 9001.

Certificat de qualité

Cher client,

Vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité.
Le système de gestion qualité de Rohde & Schwarz a été homologué conformément à la norme ISO 9001.

ROHDE&SCHWARZ

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EC Certificate of Conformity

CE

Certificate No.: 9502140

This is to certify that:

Equipment type	Order No.	Designation
UPL	1078.2008.06	Audio Analyzer
UPL16	1078.2008.16	Audio Analyzer
UPL66	1078.2008.66	Audio Analyzer
UPL-B1	1078.4400.02	Low Distortion Generator
UPL-B2	1078.4000.02	Digital Audio I/O
UPL-B5	1078.4600.02	Listening Output

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (73/23/EEC revised by 93/68/EEC)

- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1991
EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1995

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 1997-09-09

Central Quality Management FS-QZ / Becker

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1 Preparation for Use

1.1 Putting into Operation

1.1.1 Setting up the Audio Analyzer

The UPL can be operated in the following positions:

- Horizontal position: fold out the front feet provided on the instrument bottom in order to obtain an better view on the LC display.
- Vertical position tilted on its rear panel. Fold out the feet provided on the rear panel and use a 90% offset power connector (included in the accessories supplied).

Note: *To ensure optimum performance of the audio analyzer observe the following:*

- Do not cover the rear lateral ventilation openings.
- Adhere to the permissible ambient temperature specified in the data sheet.
- Avoid moisture condensation. If it has already occurred, dry out the instrument before switching it on.

1.1.2 Rackmounting

Use the adapter (see Data Sheet for type and order number.).

Note: *To ensure optimum performance of the audio analyzer observe the following:*

- Be sure sufficient air is supplied within the rack.
- There must be adequate space between ventilation openings and rack housing.

1.1.3 Power Supply

The UPL can be set to operate at AC supply voltages of **100 V**, **120 V**, **220 V** and **230 V** with a tolerance of ± 10 % and a frequency of 47 Hz to 63 Hz. It can also be operated from AC supplies with other nominal voltages as shown in the table below.

Table 1-2 Operation of UPL from other AC supplies

Nominal AC supply voltage	Setting of voltage selector	Tolerance of instrument
110 V	100 V	+ 4 % – 18 %
	120 V	+ 20 % – 6 %
115 V	120 V	+ 15 % – 10 %
127 V	120 V	+ 4 % – 18 %
240 V	230 V	+ 6 % – 15 %

Before initial power-up, check that the correct supply voltage is set. If the setting is not correct, reset as follows:

- Remove power cable.
- Open cap of voltage selector using a slotted screwdriver.
- Remove both fuse holders and insert fuses of appropriate value (included in the accessories supplied):

  Rated voltages 100 to 120 V,
  2 fuses T 4.0 H (IEC 127-2/III)

  Rated voltages 220 to 240 V,
  2 fuses T 2.5 H (IEC 127-2/III)

- Insert fuse holder.

  Remove the cylinder labeled with the rated voltages and re-insert it such that the value visible in the cap window when fitted corresponds to the desired rated voltage. If there is no suitable imprint, select the value closest to the desired one.

- Close the cap.

1.1.4 Switching On

Note: *Make sure no disk is available in the disk drive when turning the UPL ON (press ON/OFF switch on the front panel).*

Switch-on of the UPL is followed by the system start-up, selftest of the controller and loading of the MS-DOS operating system as well as of the measurement and operating software from the hard disk. While the UPL switch-on logo is being displayed, the selftest of the measurement hardware is executed (see Section 4.2 Function Test). The last UPL setup which has been automatically stored is subsequently loaded from the CMOS-RAM, setting the UPL to the status valid before switch-off.

Note: *If no characters are displayed on the screen after switch-on, the contrast control may be maladjusted (UPL02 with monochrome display only). Press the "Contrast" key in the CONTROL field of the front panel keypad and set the contrast for the desired angle of view using the rotary knob.*

For operation of an external monitor, refer to Section 2.16, Connecting External Devices.

Note:

- The system selftest also includes checking the availability of an external keyboard (see 2.17 Connecting External Devices). If an external keyboard is connected, it can be used for operating the UPL.
- Connecting the external keyboard after having turned on the UPL may involve that the software does not recognize the keyboard i.e. it is without function.
- With the use of an external keyboard, the storage test of the system can be aborted - while the storage addresses are being counted up - using the ESC key.
- The system messages output during system start-up are not displayed, since the LC display is not yet ready at this time. To make these messages visible, which is usually not required, it is necessary to connect an external monitor.
- The message

  PRESS <DEL> IF YOU WANT TO RUN SETUP/EXTD-SET

  or any corresponding message is displayed during system start-up (on an external monitor, only). Pressing this key allows you to enter the SETUP program where system configuration, date and time can be defined. We advise against calling this program as changing its settings, though inadvertently, may cause the UPL to work incorrectly or not work at all.

  Calling this program is required only after battery replacement. (Section 4.3 Troubleshooting, deals with battery replacement and setups and, in addition, how to correct a maladjusted SETUP.) If required, date or time should be changed using the DOS commands DATE and TIME (see 2.18.1 or DOS manual).

1.1.5 Switching Off

- Wait until there are no accesses to the hard disk or disk drive anymore.
- Remove the disk from the drive.
- Press the ON/OFF key on the front panel. (All UPL setups are maintained.)

1.1.6 Connecting an External Keyboard

Note: *Connect the keyboard only with instrument switched off. Otherwise, correct function of the keyboard cannot be guaranteed.*

The keyboard connector is fitted to the rear of the instrument (KEYBOARD label). Any standard PC keyboard may be used.

In normal operation, the keyboard facilitates the entry of commentary texts, file names etc. If the controller mode of the UPL is selected, e. g., in order to store measurement results in documents, the keyboard assumes its usual PC function (cf. 2.18 UPL Used as Computer).

Section 2.1.1 (Front View of the Instrument) includes an overview of the assignment of the key functions of the UPL front panel to short-key combinations of the external keyboard. This assignment table can be looked up at any time in the help function (press front panel key HELP or F1 on the ext. keyboard) under the key-word "UPL".

The automatic repetition rate with constant key stroke and the associated delay can be modified in the OPTIONS panel (Rep rate, Rep delay).

Either a keyboard with German or English key assignment can be selected:

- change to DOS (press SYSTEM key)
- call "BOOTSET" program and make appropriate selection
- enter UPL to return to measuring operation

1.1.7 Connecting a Mouse

Note:
Connect the mouse only with the instrument switched off. Otherwise, correct operation cannot be guaranteed.
The complete UPL may be mouse-controlled. Particularly, the entry of commentary texts, file names etc. is easier than via the front panel keys, only (selecting the keys of a "screen keypad"). Mouse control is described in Section 2.3.

The UPL requires the appropriate mouse driver in the path C:\MOUSE of the UPL named mouse.com., which must be available on a 3.5"-disk.

Proceed as follows:
(In the subsequent example, the mouse driver to be installed is called msmouse.com and is located in the root directory of the disk)

- Connect external keyboard. Connect mouse to the interface COM1 and switch on the instrument
- Press ESC while the UPL switch-on logo is displayed to change to the DOS level
- Insert the disk with the driver to be installed in the 3.5" drive.
- Execute the following DOS command: copy a:msmouse.com c:\mouse\mouse.com
- Enter UPL: the UPL operator surface is started.

1.2 Fitting Options

All options can be fitted by the user. Additional test instruments are not required for putting into operation.

Important!
All options are sensitive to electrostatic charge. Handle them in line with ESD regulations!

Assembly (applies to all options):

- Turn the UPL off, disconnect the power cable.
- Unscrew the feet from instrument rear (four Phillips screws).
- Slide the upper paneling slightly to the rear and withdraw.
- After having fitted the option according to the supplied assembly instructions, remount all covers, brackets and clamps in reverse order to that of removal. Fit the paneling and the instrument feet.
- Turn the UPL on. Install the supplementary software supplied, if any, according to instructions or enable additional software functions. The software then automatically recognizes the fitted option. If a calibration is required, it can be performed without any external test facilities being required.

When ordering one of the following options:

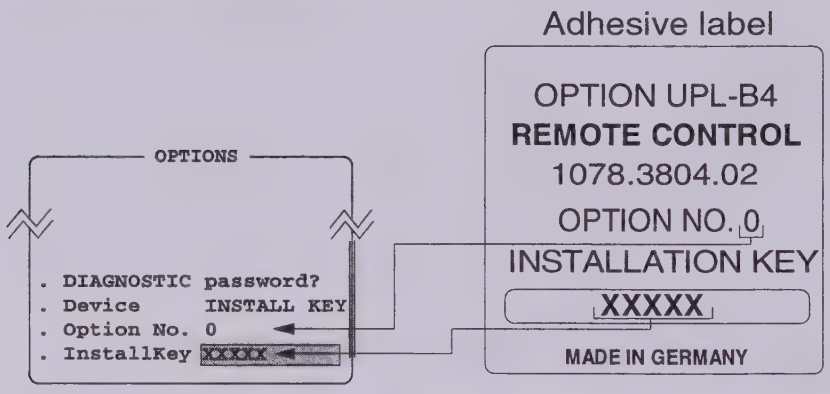
- Universal Sequence Controller UPL-B10 Order No. (1078.3904.02)
- Digital Audio Protocol UPL-B21 Order No. (1078.3856.02)
- Jitter and Interface Test, UPL-B22 Order No. (1078.3956.02)
- Remote Control UPL-B4 Order No. (1078.3804.02)
- Extended Analyzer Functions UPL-B6 Order No. (1078.4500.02)

make sure to indicate the serial number on the rear of the instrument (SER. xxxxxxxx)

1.2.1 Enabling Software Options

If one of the above-mentioned options is cleared by mistake, a reinstallation is to be performed as explained below, **Remote Control (UPL-B4)** being used as an example:

- Switch on the instrument
- Select the OPTIONS panel using the OPTIONS key on the UPL front panel or by pressing ALT+O on the external keyboard and scroll to the panel end by means of the cursor or the paging key.
- Enter the numbers on the label attached to the rear of the instrument in the fields labeled **Option No.** and **InstallKey** of the OPTIONS panel as shown below:



With the installation key correctly entered the following message is displayed:

Option installed!

After switching the UPL off and on again, the option is ready for use.

If the entry of the installation key was not correct, the following message is displayed:

Wrong Installation Key! Turn power off and restart UPL!

After switching the UPL off and on again the procedure can be repeated.

If the installation key is re-entered without switch-off/on of the UPL, the following message is displayed:

To retype Installation Key, turn power off and restart UPL!

1.3 Software Installation

The following floppy disks are supplied together with the UPL:

- MS-DOS system floppies, containing all programs associated with MS-DOS.
- UPL program floppies, including the complete UPL operating and measurement software.
- UPL Example Disk. It contains examples for remote control via IEC/IEEE-bus and for Universal Sequence Control UPL-B10. as well as setups to different measurement applications.

The UPL is supplied with the operating system and the UPL software including example files already installed on the built-in hard disk. The supplied floppy disks are needed only when the complete software or parts thereof have been deleted inadvertently by the user. The MS-DOS, UPL software and example files can also be installed separately.

Note: *The UPL software is supplied in packed format and unpacked only during installation (the software then considerably exceeds the capacity available on the disk). The unpacking program may output messages such as "Exploding...", "Unpacking" etc. These messages are correct and do not mean faulty installation.*

Installing the MS-DOS operating system:

- Connect the external keyboard.
- Switch on UPL, insert 1st disk.
- Enter A:SETUP
- Press CTRL + ALT + DEL (or STRG+ ALT+ ENTF) keys.
- The installation program is started.

Continue the installation following the notes on the screen.

Installing the UPL operating and measurement software:

- Connect the external keyboard.
- Switch on UPL.
- Exit the UPL operating software by pressing ESC key while the switch-on logo is being displayed on the screen, or, with the UPL operating software loaded, by pressing the SYSTEM key and Enter (corresponds to "Normal Exit to DOS" in the selection box).
- Insert the UPL program disk.
- Key in A :, press Enter.
- Key in UPLINST, press Enter.

The UPL software is now copied onto the hard disk.
Continue the installation following the notes on the screen.

The UPL user interface is be displayed on the LCD screen.

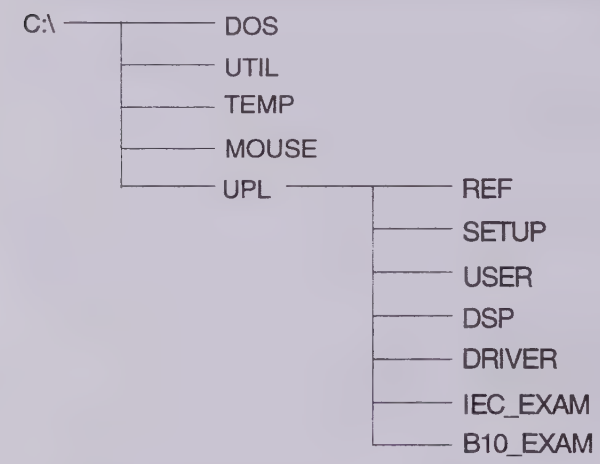
Note: *If an updated version of MS-DOS or of the UPL software is to be installed, proceed as described above.*

Installation of UPL example files::

- Connect the external keyboard.
- Switch on UPL.
- Exit the UPL operating software by pressing ESC key while the switch-on logo is being displayed on the screen, or, with the UPL operating software loaded, by pressing the SYSTEM key and Enter (corresponds to "Normal Exit to DOS" in the selection box).
- Insert the UPL example disk.
- Key in A :, press Enter.
- Key in SETINST, press Enter.

The UPL example files are now copied onto the hard disk. Then the UPL operating software can be started as usual.

The files copied onto the hard disk during installation are stored in the following directory structure:



The READ.ME file in the C:\ directory refers to the contents of the individual directories and files.

After installation, the \DOS, \UTIL and \UPL paths are defined.

Note: *To ensure correct functioning of the UPL measurement and operating software, do not modify the directory structure stated above nor the paths.*

2 Manual Operation

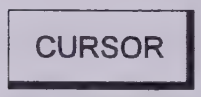
Note: *You do not need any specific knowledge as to the MS-DOS operating system for use of the UPL.*

We assume that you know what is meant by e.g. a file, a directory or a path and do not provide any further explanations on that.

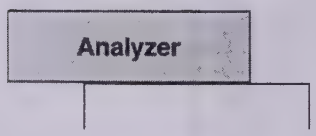
If you do not have this knowledge or, if the UPL is to be used as a computer (see Section 2.17, UPL Used as Computer) for e.g. data reprocessing, please refer to the MS-DOS manual.

Legend of graphic symbols used in this manual:

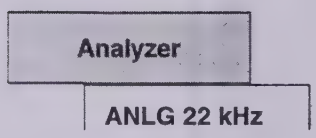
Front-panel keys



Softkey



Menu item of a panel



Parameter of a menu item

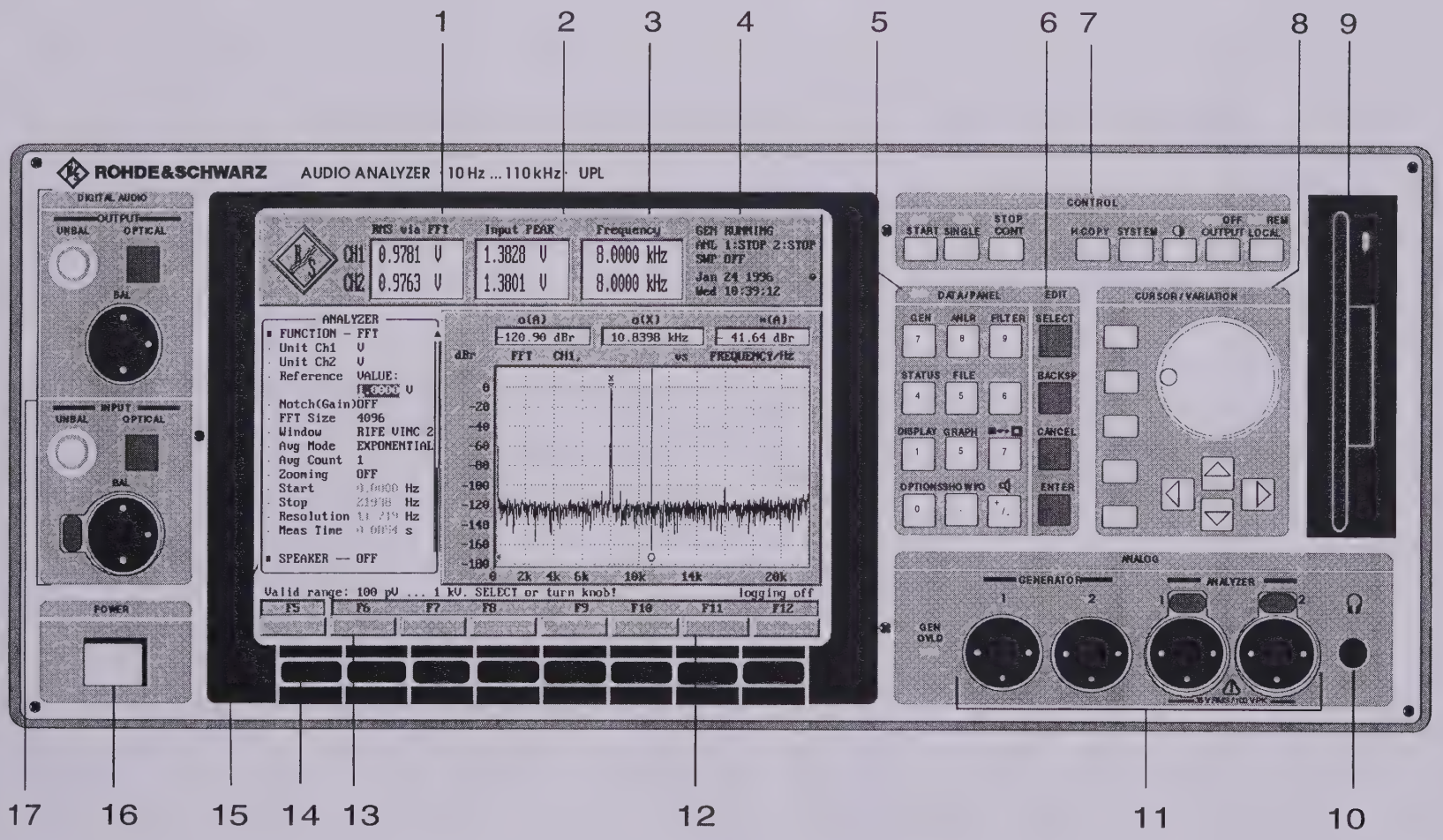


Fig. 2-1 Front-view

2.1 Explanations of Front- and Rearpanel Views incl. Key Combinations on the External Keyboard

2.1.1 Front-panel View

1

Display of the result of a selected measurement function, simultaneously for channel 1 and 2

2

Display of a second measured value per channel, e.g., peak level of input signal, simultaneously for channel 1 and 2

3

Display of frequency for both input signals or of frequency and phase between both input signals

4

Current mode of generator, analyzer and sweep system. Date and time.

5 DATA / PANEL

Keypad with dual assignment:

DATA-LED ON: Keys serve as numeric keypad (± key switches the sign over)
DATA-LED OFF: Keys are used to call a panel (see 2.3.1 Panels); the labeling above the keys is valid:

Front-panel key	**Key combination** External keyboard	**Function**
GEN	Alt G	Settings of all generators (see 2.5 Generators (GENERATOR Panel)
ANLR	Alt A	Settings of all analyzers (see 2.6 Analyzer PANEL)
FILTER	Alt T	Filter definitions of analyzers (see 2.7 Analyzer Filters (FILTER Panel)
STATUS	Alt S	Sum up user-definable menu items of any panel (see 2.8 STATUS Panel)
FILE	Alt F	Loading and storing traces and lists (see 2.9.1), editing files and directories (see 2.9.2)
DISPLAY	Alt D	Parameters for graphical display of results (see 2.10 Graphical Data Presentation)
GRAPH	Alt R	Activate panel or graphical display (toggle function)
□◄►□	ALT Z	Switch between full-screen and part-screen mode (toggle function) (see 2.10.9)

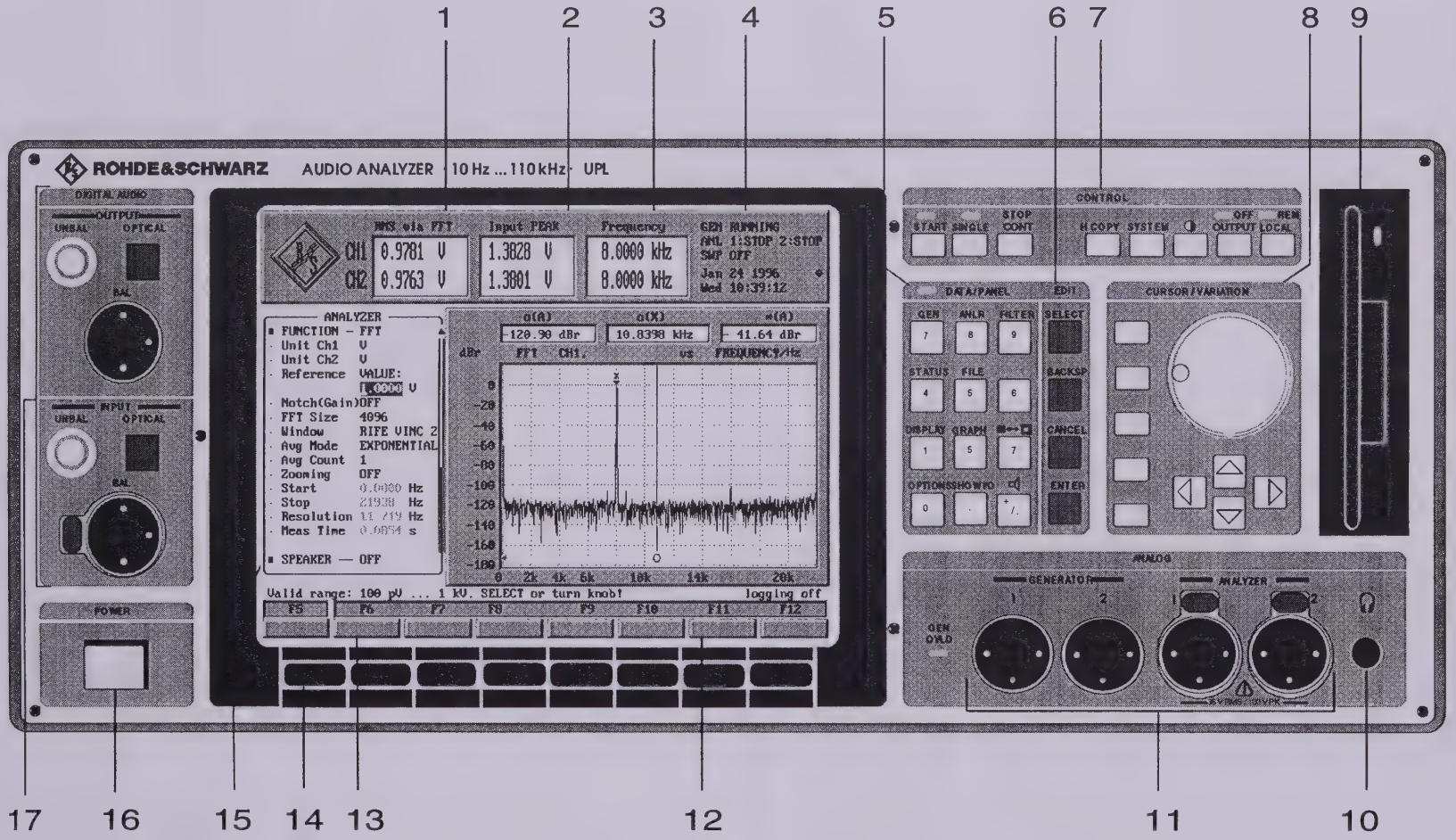


Fig. 2-1 Front-view

5 DATA / PANEL

Keypad with dual assignment:

DATA-LED ON: Keys serve as numeric keypad (± key switches the sign over)
DATA-LED OFF: Keys are used to call a panel (see 2.3.1 Panels); the labeling above the keys is valid:

OPTIONS	Alt O	Parameters for printout (see 2.14 Printing/ Plotting) and auxiliary settings (see 2.15 Setting and Displaying Auxiliary Parameters)
SHOW I/O	Alt I	Front-panel display with the selected inputs/ outputs marked; explanations in the case of indistinct input signals
+/-		Open a box for setting the monitoring volume if the Option UPL-B5 (Monitor Output) is installed.

6 EDIT keypad

(see 2.3.2 Data Entry)

SELECT	Space	Open a selection, input or dialog window, selects characters in the entry box for entering text without external keyboard
BACKSP	*	Delete the character before the cursor
CANCEL	Esc	Close open window, the old value or parameter will remain effective
ENTER	Enter	Close open window, the new value or parameter will be accepted

7 CONTROL keypad

START	Ctrl F5/ Strg F5	Starts continuous measurement or sweeps. (→ LED lights up). Resets min. and max. values of bargraph display, average values and average traces (see 2.11 Starting and Stopping of Measurements or Sweeps)
SINGLE	Ctrl F6/ Strg F6	Starts a single measurement or single sweep. LED lights during a single sweep (see 2.11 Starting and Stopping of Measurements or Sweeps)
STOP/CONT	Ctrl F7/ Strg F7	Stops or continues measurement or sweep (toggle function) (see 2.11 Starting and Stopping of Measurements or Sweeps)
H COPY	Ctrl F8/ Strg F8	Prints a hard copy of screen (see **2.14.1 Screen copy to** printer (pixel-oriented))
SYSTEM	Ctrl F9/ Strg F9	Return to MS-DOS (see 2.18 UPL Used as Computer)

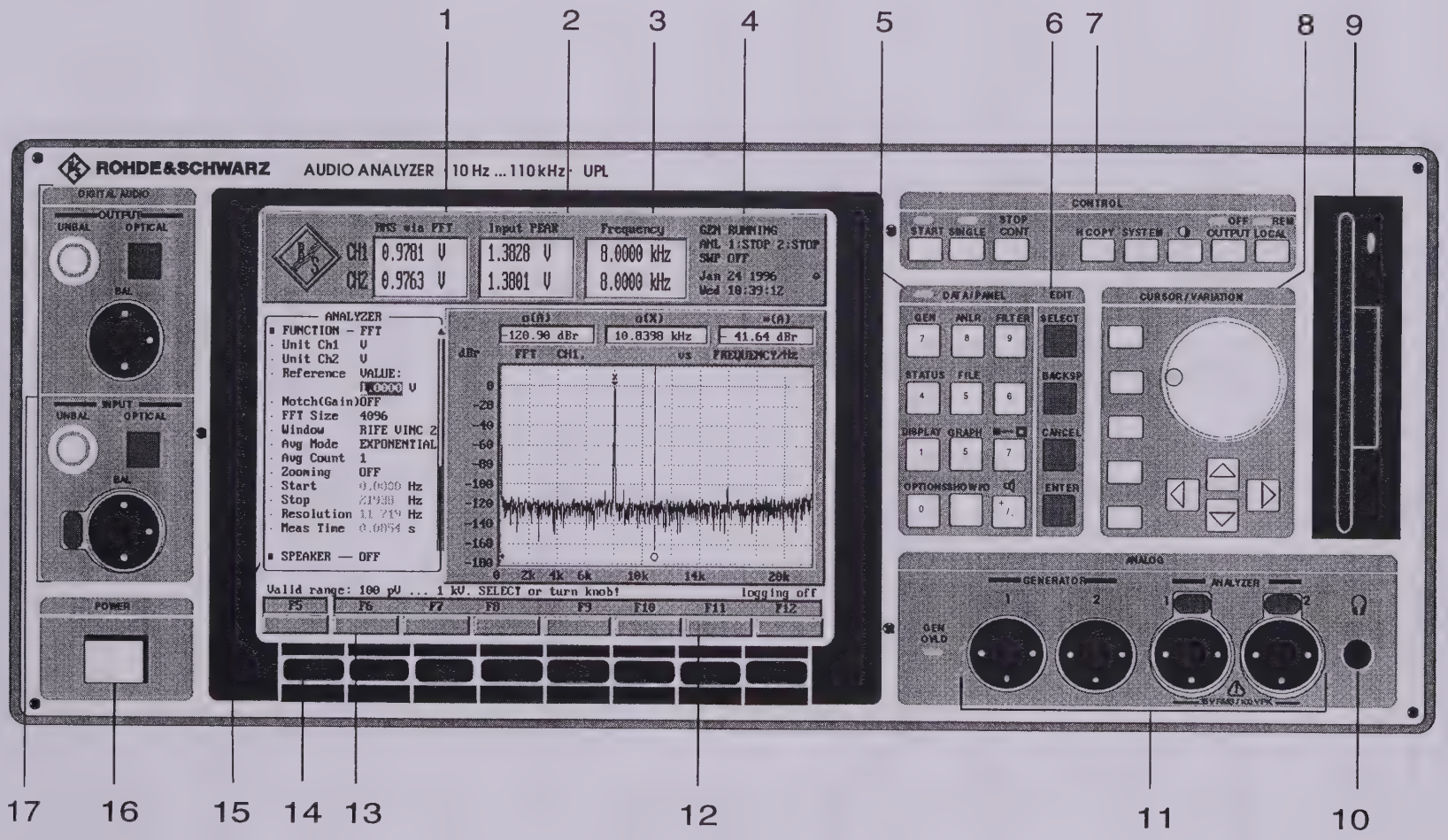


Fig. 2-1 Front-view

7 CONTROL keypad

◑	Ctrl F10/ Strg F10	Open window for setting the contrast of the LCD via rotary knob.
OUTPUT	Ctrl F11/ Strg F11	Switches all outputs ON/OFF (OFF: LED lights up) (see 2.13 Fast Switch-off of Outputs)
LOCAL **(Speaker off)**	Ctrl F12/ Strg F12	Switch from remote to local mode (Remote control: LED is ON) In LOCAL mode, the internal loudspeaker and, optionally, the connected headphones are switched on/off if the option UPL-B5 (Monitor Output) is installed.

8 CURSOR / VARIATION keypad

(see 2.3.2 Data Entry, 2.3.1 Panels)

HELP	F1	Opens a help window
→|, |*	→|, |*	Tabulator right/left; change to the next input field to the right or to the left, may be used also for toggling between input panel and graphical window
PAGE*, PAGE*	Page *, Page * Picture*, Picture *	Turn pages in a panel or move windows back and forth If the graphical window is activated (by means of the GRAPH key or Alt R, and discernible from the softkeys being labeled with the graphics control functions), the PAGE keys are used to scroll up or down the scan index (see 2.9.3.3, Scans count >1).
*, *	*, *	Move the cursor up/down
→, *	→, *	Move the cursor to the left, right; only effective in an open input window. In the graphical window, too, the cursor position is changed unless MANUAL SWEEP is selected. With MANUAL SWEEP (started by means of the START key), the sweep steps are advanced by means of the horizontal cursor keys. When the STOP key is pressed, switchover is made back to the graphics cursors. In manual sweeps, the rotary knob has the same function as the horizontal cursor keys.
Rotary knob	Cntrl * / Strg * Cntrl → / Strg →	Increment or decrement the number on the cursor position, move the active cursor in the graphical display

9

3.5" disk drive, LED indicates a read or write access

10

Headphones connector (Option UPL-B5)

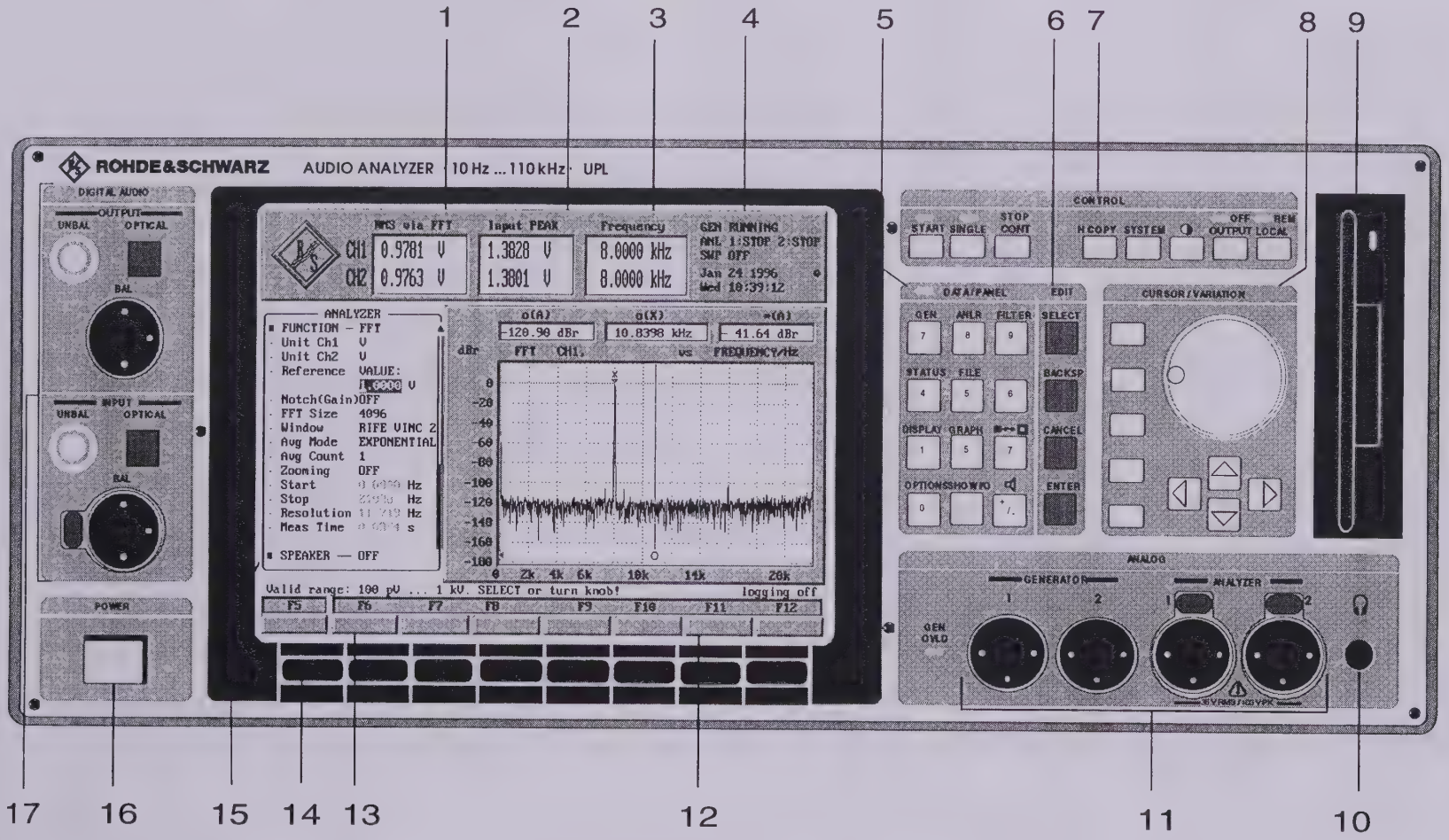


Fig. 2-1 Front view

11

Input and output connectors of the analyzers and generator for the analog interfaces (see 2.5.2 Configuration of the Analog Generator and/or 2.6.2 Configuration of the Analog Analyzers)

12

Graphical presentation of results, the measured values at the cursor positions being used.

13

Operator guidance line, also indicating the permissible range of values during data entry.

14

Softkeys. Entry of units and operation of the graphical display; can also be activated via mouse or function keys of external keyboard.

15

One of altogether 7 panels, each containing all the appertaining settings

16 Power Switch

17

Input and output connectors of the analyzer and generator for the digital interfaces (Option UPL-B2, see data sheet for order No.); see 2.5.3 Configuration of the Digital Generator / 2.6.3 Configuration of the Digital Analyzer.

Unbal:	BNC connector
Optical:	Interface EIJ CP-340, system TOSLINK
Bal:	XLR connector

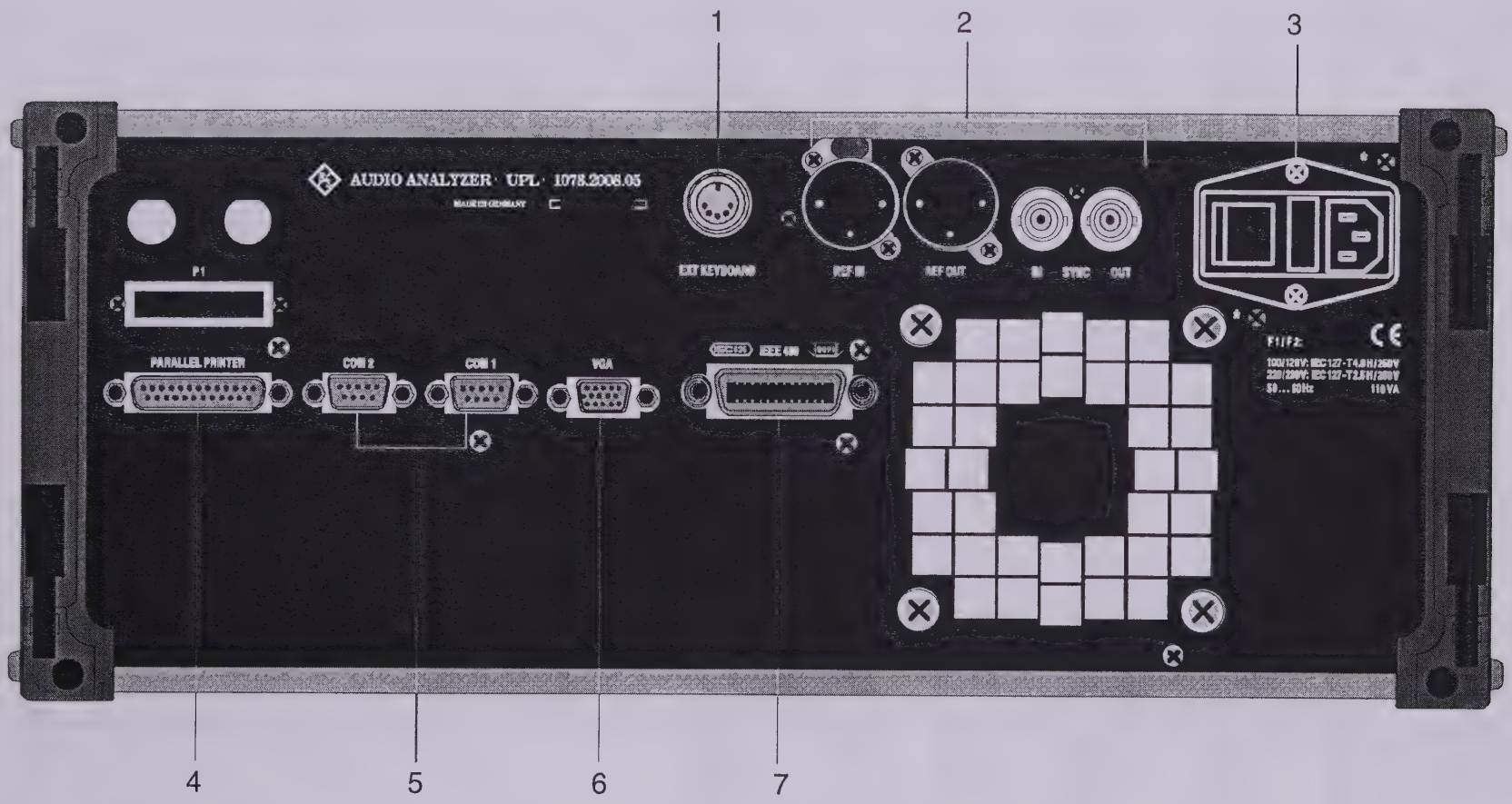


Fig. 2-2 Rear-panel view

2.1.2 Rear-panel View

1

Connector for an external keyboard (see 1.1.6, Connecting an external keyboard)

2

Inputs and outputs for reference and sync signals of the digital audio interfaces (Option UPL-B2) (see UPL-B2 data sheet)

REF IN:	input for a digital audio reference signal (DARS)
REF OUT:	output for a digital audio reference signal generated by UPL
SYNC IN:	synchronization input for wordclock and video signals
SYNC OUT:	synchronization output for synchronization of external devices (e.g., oscilloscope) to digital input signal

3

Display of the set ac voltage

4

IEC-BUS female connector (IEC-625/IEEE-488), Remote Control Option (UPL-B4) required, (see data sheet for order No.) (see Section 3, Remote Control)

5

Connector for an external VGA monitor, 15-contact D-SUB female connector, triple-row

6

two RS 232-C interfaces, 9-contact D-Sub female

7

Parallel printer interface, 25-contact D-Sub female

2.2 Operating Instructions

2.2.1 Brief Introduction

General

Subsequent to switch-on, the instrument assumes the same state as prior to switch-off. This applies to ***all setting parameters*** of the UPL, i.e., also for those which are currently not displayed.

The UPL is operated using the cursor (inverted field) ,the rotary knob and the keys SELECT, BACKSP, CANCEL and ENTER . The cursor indicates the input field for which an entry is expected. The cursor can be moved from one input field to another using the rotary knob or one of the keys ↑, ↓, PAGE↑, PAGE↓, Tab → and Tab ←. The cursor cannot be placed on fields with indicating function only. They are displayed in a different gray or another color.

Panel Structure

Associated functions and settings are displayed together in panels:

- **Analyzer panel**
  - selection of the instrument (analog or digital interfaces, frequency range)
  - configuration of the interfaces
  - measuring functions (incl. sweeps of tracking filters)
  - trigger conditions (incl. ext. sweep)
  - selection of the filters
- **Generator panel**
  - selection of the instrument (analog or digital interfaces, frequency range)
  - configuration of the interfaces
  - selection of the test signals incl. level setting
  - sweep of the generator signals
- **Filter panel**
  - definition of the filter characteristics
- **File panel**
  - storage and loading of instrument settings and measured-value sequences
  - editing of files and directories
- **Display panel**
  - definition of the type of graphical display
  - scaling of x and y-axes
  - selection of multiscans
  - entry of tolerance lines
- **Graph panel**
  - selection of cursor and marker functions
  - graphical analysis of the measurement results
- **Status panel**
  - user-configurable panel (only in combination with graphical display)
- **Options panel**

  settings for

  – remote control
  – parameter link
  – printer/plotter
  – COM2-interface
  – external keyboard

- external monitor
- display of the measurement result: selection of the number of digits and update rate
- display mode and language of the help texts
- version numbers of hardware and software and options fitted
- calibration
- installation of options

Basic rules of operation

- **First select the instrument (both generator and analyzer)**

  Reason: An individual set of parameters is provided for each instrument. This parameter set is saved when changing the instrument and restored when returning to the instrument. It must be loaded first before beginning to make new entries. When changing an instrument, the current choice of functions may change also (e.g., analog instruments do not offer selection of the sampling rate..).

- **Always proceed from "top to bottom" in the panels.**

  Reason: Variations in parameters of individual menu items may affect the selection or the range of values of menu items further down, however not of menu items above.

- **Edit the DISPLAY panel only after the generator and the analyzer have been set.**

  Reason: Everything which can be displayed graphically also depends on the selected measurement function.
  Many setting parameters of the DISPLAY panel are automatically adopted from other panels, if desired, eliminating the need for setting display parameters.

Selection of function and entry of values

Selection of functions and parameters:

First open input box (SELECT key or space key on external keyboard), then

either:	- select function or parameter using the arrow keys
or:	- enter the first letter of the desired function on the external keyboard

Pressing the "Enter" key acknowledges the selection, "CANCEL" retains the previous selection.

Entry of numeric values:

either:	- open the input box (SELECT key or space key on the external keyboard or first digit of the number to be entered) - numeric entry - terminate with "Enter" the unit remains unchanged
or:	- open the input box and do the numeric entry (as above) - terminate by selecting the unit via softkey (or the corresponding function key on the external keyboard)
or:	– switch the rotary knob function to "value change mode" by pressing one of the keys ENTER, ← or → – vary the numeric values using the rotary knob, the position of the digit to be changed can be selected using the cursor keys (← or →)

The permitted range for the selected function is displayed in the operator guidance line (between panels and softkeys).

Help Functions

The UPL provides a manifacility of help functions to support the user:

1. HELP function

- A HELP information is provided for each input field, optionally in German or English (HELP key or F1 of the external keyboard, selection of the language in the option panel).
- The help information corresponds always to the firmware version of the instrument

2. ONLINE help

The permitted range for the selected menu item is indicated in the operator guidance line (between the panels and the softkeys), respectively.

3. Entries exceeding the specified range

Entries which exceed the specified range permitted for the selected function are not accepted, an acoustic warning is output and the entry is modified to the respective minimum or maximum value.

4. SHOW I/O key

If the measured value can not be displayed, e.g., due to a missing or inappropriate input signal, the message "-Input?- Press SHOW I/O" is displayed. Pressing this key causes notes on possible error causes to be displayed together with the input and output configuration.

5. OUTPUT OFF

All UPL outputs can be switched off using this key, e.g., in order to protect a connected device under test.

2.2.2 Introductory Examples

This section provides an introduction to the operation of the UPL via the front-panel keyboard by way of examples which base on each other (operation via external keyboard or mouse, see Section 2.3 General Instructions for Use).

The examples are:

- Loading the default setup
- Frequency response measurement of the analog UPL generator from 15 Hz through 20 kHz using the sweep function
- Cutting in a filter
- Ways of presentation of measurement results
- FFT of a two-tone signal, measured at digital interface
- Hard copy of screen

Note: *Menu items which are not explained in the examples remain unchanged.*

Example 1: Loading the Default Setup

(Only required to ensure that equal conditions prevail in the examples given below)

FILE

5

Press the figures key 5 on the front panel. As the instrument is currently not expecting a numerical input (LED above the figures keys does not light up) the secondary function indicated above the keys is automatically executed. In this example, it is the FILE function.
Causes the appertaining panel (= input window) to be displayed on the screen. The panel contains the menu items dealing with file management.

Mode

DEF SETUP

Using the keys above, place the cursor to the input field in the second line of the panel (= right-hand column of menu item "Mode" under the heading LOAD INSTRUMENT STATE), press SELECT, select DEF SETUP with the cursor, close the window using ENTER. The UPL default setup is loaded.

Note: *The operator sequence "SELECT, selection with the cursor, ENTER" is always necessary to select a parameter, is however not explicitly stated in the following explanations.*

Example 2: Frequency Response Measurement of the UPL Generator in the Range from 15 Hz to 20 kHz using the Sweep Function

Analyzer settings:

FILTER

9

ANLR

8

Causes the panels for setting the analyzer filters to be displayed on the screen instead of the display panel and then changes to the analyzer panel. The cursor is always located in the last-selected panel.

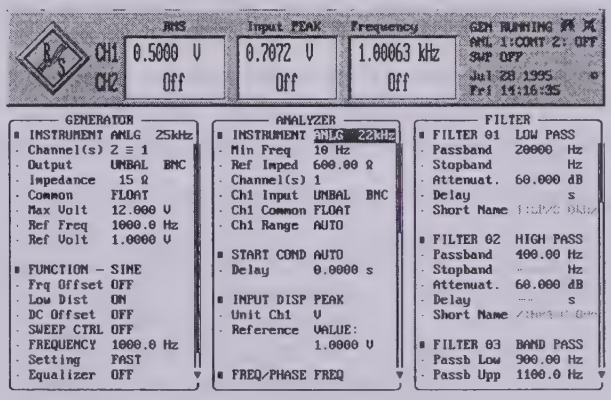


Fig. 2-3

ANALYZER

ANLG 22 kHz

Define which one of the three analyzers is to be used. The preset parameter is ANLG 22 kHz, which is designed for the analog interfaces and the frequency range up to 22 kHz. The panel displayed on the screen indicates all possible ways of setting this analyzer; the settings of the other analyzers, e.g. the analyzer DIGITAL are suppressed, however retained.

Channel(s)

1&2

Define which channel is to be measured. Select two-channel measurement.

CH1 Input

GEN CH2

Select the input on which the measurement is to be carried out. Switch channel 1 to GEN CH2 and channel 2 to GEN CH1. The generator outputs are now connected internally crosswise to the analyzer inputs. (This feature is required, e.g., for performing precise gain measurements or, as in this example to execute the examples without changing external connections.)

CH2 Input

GEN CH1

FREQ / PHASE

Freq &Phase

Switch to simultaneous frequency and phase measurement.

FUNCTION

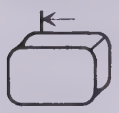
RMS&S/N

Define the measurement function. All measurement capabilities are listed in the selection window (SELECT key). Keep the preset RMS measurement (CANCEL key).

The UPL measures continuously, which is why the measurement results of the signal currently output by the generator are already displayed on the upper range of the screen:

- the first window shows the results for both channels of the selected measurement function, which is here the rms measurement (the heading of the window reflects the selected function)
- the second window gives the peak level of the input signal, also for both channels
- the third window outputs the frequency of the input signal and the phase between both channels

Generator settings:



Switch to the next input field (to the left); in this case, when pressing the key no more than twice, to the GENERATOR panel and to the position the cursor was placed when the panel was left, in this example the first line.

GENERATOR

ANLG

Specify which one of the five generators is to be used. The preset parameter is ANLG, which is the generator for the analog interfaces.

FUNCTION
SINE

Specify the type of signal to be output. The selection window lists all possible types of signals. Keep the presetting, which is sine-wave.

SWEEP CTRL
AUTO SWEEP

Define whether a sweep is to be carried out, whether the sweep is specified by parameters or a list and whether the sweep is to be continued automatically or manually via rotary knob. Switch to AUTO SWEEP. The panel shows some additional lines in which the sweep parameters are to be specified:

X Axis
FREQ

Define which parameter is to be swept, here the frequency.

Start
20 kHz

Specify the start and stop values of the sweep. With a frequency sweep selected, frequency values are expected:
Enter the start value of 20 kHz: place the cursor to the input field, press SELECT (the LED DATA above the entry block for digits lights up indicating that these keys have now the function of figures keys and cannot be used to select panels), key in 20, press softkey kHz (= F6), thus closing the input window. Select the input field for the stop value using the cursor key.

Stop
15 Hz

Place the digital cursor to the second position using the ←→ key, set 15 Hz using the rotary knob.

VOLTAGE
1.0 V

Specify the output voltage. Set to 1.0 V.
The permissible range of values is output in the operator guidance line (above the softkeys).

Note: *The maximum level which is still permitted to be output can be defined in the menu item "Max volt" (upper section of panel) (protects custom circuits against destruction in case of a keying error). The upper range limit permissible for inputs is thus limited to this value and accordingly varied in the operator guidance line.*

Setting the Display Parameters:

DISPLAY
1

Causes the DISPLAY panel to be displayed on the screen (at the former position of the FILTER panel) and the cursor to be placed in this panel. Contains all parameters concerning the graphical presentation.

OPERATION
CURVE PLOT

The standard setting CURVE PLOT is used to display the measurement results in the form of a curve.

Trace A
FUNC CH1

Define which data are to be collected in the measured value memory A. Here, the parameter FUNC CH1 specifies the results of the function currently active for channel 1. With rms measurement selected in the analyzer, the results of this measurement are collected.

Unit
dBr

Specify the unit with which the Y axis is to be scaled. (It is possible to select a different unit from that selected in the ANALYZER panel for numerical display of the measurement result. A different unit can be selected even at a later date in order to rescale an already available trace.)
Hint: The ↑ key allows for jumping to the end of the selection box, thus obtaining dBr very fast.

Scale
MANUAL

The standard setting AUTO ONCE causes the scaling to be effected automatically whenever a measurement function is changed. At the beginning of the sweep, the full-scale values are set to a useful start value. After the sweep has been completed, the measured full-scale values are taken as the basis for rescaling.
Switch to Manual. Scaling can now be specified in the lines Top and Bottom.

Top
0.2 dBr

Bottom
-0.2 dBr

Enter the full-scale values +0.2 dBr and -0.2 dBr.
The full-scale values can be entered in units other than specified for scaling of the axis. (Renders conversion of the full-scale values when changing the scaling unit unnecessary.)

Trace B
PHASE

The phase measurement values are collected in the measured value memory B.

Scale
MANUAL

Switch to manual scaling. The scale for trace B is displayed in the right-hand margin of the graphics window.

Top
+ 1°

Enter full-scale values of ±1°.

Bottom
- 1°

X AXIS

FREQ

Indication value only. Is automatically set to the sweep control variable.

Scale

Auto

Automatically scale the x axis with the start and stop values of the sweep.

Spacing

LOG

Select between linear and logarithmic scaling of the x axis (=sweep parameter). Keep the presetting LOG.

GRAPH

2

Toggle key switching from the selected input panel to the window for graphical presentation of traces, bargraphs or trace lists and vice versa. Press the key.
The graphics window will appear in **full** display (because the key was pressed when the panels were shown in full display, i.e. 3 panels simultaneously).

□◄►□

3

Switches from full-screen to part-screen mode and vice versa.

The panel most recently selected (here: DISPLAY panel) is shifted to the left on the screen, the GRAPH window being displayed next to it on the right side instead of the other two panels (part-screen mode).

SINGLE

Start a single sweep. The current measured values are output in the measurement result window and, at the same time, both traces are displayed. The sweep starts at the high frequencies (because of start value=20 kHz). The graph window is now active, i.e. the → and ← keys, the rotary knob and the softkeys refer to the graphical display.

The measurement of the sum frequency response of generator and analyzer is thus complete.

Example 3: Cutting in a Filter

DISPLAY
1

Select the DISPLAY panel.

TRACE B
OFF

Switch off trace B.

TOP
10 dBr

Reset the top full-scale value of trace A to 10 dBr and the bottom full-scale value of trace A to -90 dBr.
You can select Scale Auto Once instead, causing the scaling to be automatically matched at the end of the sweep.

Bottom
- 90 dBr

□◄►□
3

Switch from part-screen to full-screen mode (here: 3-panel display as the cursor was in a panel).

FILTER
9

Select the FILTER panel. Up to 9 filters can be defined by the user at the same time: Enter the type of filter (lowpass, highpass...), attenuation, passband or center frequency and bandwidth you wish to use in the menu item "FILTER XX", finished. To make the entry more convenient for you, some filters are predefined.

Filter 05

Scroll to the first notch filter.
The parameters displayed in green or gray are values which have been determined by the internal filter design program. These values are for your information and cannot be changed.

HELP

If you need help, press the Help key to open the help window, which provides you with brief information on the current menu item, here the filters. You may select key words highlighted in the help text and obtain further information on these items by pressing SELECT.

CANCEL

Cancel closes the help window (also ENTER).

Center Frq
4 kHz

Set the center frequency to 4 kHz, the (band)Width to 500 Hz and Atten(uation) to 50 dB. The filter is now defined and is automatically designated "5:NO4000 Hz".

Select the ANALYZER panel using e.g. the tabulator key (press twice) and scroll to its end using e.g. the Page ↓key.

Filter

5:NO4:00 KHz

Define the filters activated in the selected rms measurement. Scroll to the first menu item "Filter" under the heading FUNCTION, open the selection window containing a list with the nine filters defined in the FILTER panel together with their short designations and all weighting filters. All settable filters can be made visible by scrolling with the ↓ and ↑ cursor keys.
Place the cursor on Filter 5:NO4000 Hz and select using Enter.
The filter is now being calculated. The displayed filter parameters are UPLated in the FILTER panel.

Select the GENERATOR panel.

Frequency:

Spacing

LIN Points

Select linear spacing between sweep variables.

Start

3500 Hz

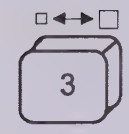
Change the start and stop values of the sweep to 3500 Hz or 4500 Hz in order to facilitate analysis of the stopband of the notch filter.

Stop

4500 Hz

Stop

4500 Hz



Switch from full-screen (3 panels) to part-screen mode.

SINGLE

Start a new sweep. The frequency response for channel 1 with the notch filter activated is displayed. Scaling of the X-axis is automatically matched to the new sweep values.

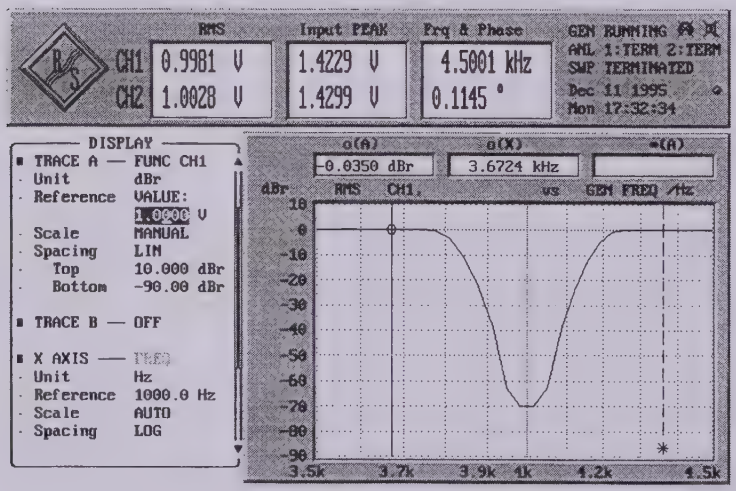
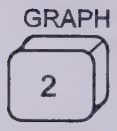


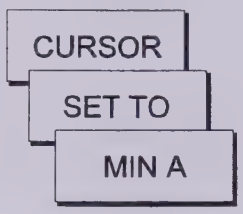
Fig. 2-4

Example 4: Ways of Presentation of Measurement Data

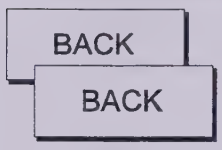


The graphical display window is activated, i.e. all entries (e.g. via rotary knob, softkeys) are relevant for graphical display.

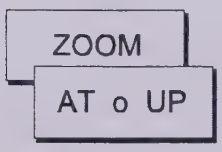
The softkey indicates by the filled circle which cursor is active, i.e. can be moved using the cursor keys or the rotary knob (in the example 0-cursor). Select the 0-cursor by pressing the softkey.



Graphical display and the cursor function can be altered using these softkeys. The key sequence CURSOR, SET TO, MIN A, for example, sets the (active) cursor to the minimum value of the sweep.

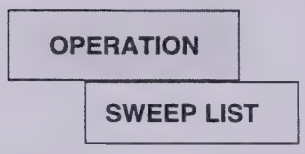


The Back softkey allows you to return to the next higher menu level. Press twice.

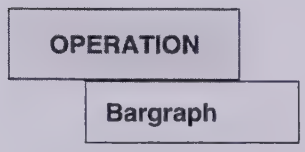


The X-axis is zoomed symmetrically around the 0-cursor by the factor of 2 with each pressing of the key.

Select the DISPLAY panel.

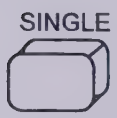


Display of measured value list for the most recent sweep. This list can be stored e.g. for further processing (FILE panel, "STORE TRACE/LIST": "STORE" ∅ "TRACE A", select a file name).



Select bargraph display. The function to be displayed and the other parameters can be selected independently for each bargraph. The minimum and maximum values indicated are reset whenever the START key is pressed.

Start a continuous sweep. The current rms values and frequency are indicated in bargraph display.



Ends the continuous sweep at the end of the last sweep.

Example 5: FFT of a Two-tone Signal, Measured at Digital Interface

Select full-screen mode for the panels.

Select the GENERATOR panel.

GENERATOR
DIGITAL

Select the generator for the digital interfaces.

Channel(s)
1

Set single-channel output.

FUNCTION
DFD

A difference tone is generated. A box is first displayed containing the question: „Really Parameter Link Yes/No". Yes means that the corresponding DFD measurement is automatically switched on in the analyzer. Acknowledge by entering NO in this example, since an FFT is to be made. Select mean frequency (enter in menu item "Mean Freq") and difference frequency (menu item "Diff freq") is generated. The total level is 100 % FS (full scale), i.e. the peak value of the level matches the maximum number that can still be displayed ("all bits set").

MEAN FREQ
10 kHz

Enter mean and difference frequency.

DIFF FREQ
80 Hz

Select the ANALYZER panel.

ANALYZER
DIGITAL

Select the analyzer for the digital interfaces.

Input
Intern

Switch to the internal digital interface to the generator. The generator is connected internally to the analyzer. (The internal sample rate is fixedly set to about 43 kHz.)

Function
FFT

Select FFT analysis (selection in a box can always be made, alternatively, by entering the first letter on the external keyboard, i.e. „F“ in this example).

FFT-Size
8192

Specify the size of the calculated FFT in number of points. The higher the FFT, the higher the frequency resolution (see DISPLAY menu item "Resolution"), however the more the measuring time (see DISPLAY menu item "Meas Time").

Display

Trace A:

Unit
dBFS

Select unit of the y-axis. Scaling is then made automatically, since the parameter “Scale“ is set to “AUTO ONCE“.

Switch to part-screen mode.
The spectrum of the difference tone signal is displayed.

ANLR

Select analyzer panel.

Zooming
ON (2 ... 128)

Increases the frequency resolution by one center frequency (menu item "Center") through digital preprocessing of the signal by the zoom factor (DISPLAY menu item "Zoom-Fact"). The frequency range displayed is thus decreased by the same factor (menu item "Span").

Note: *Not to be confused with the Zoom in Graph where the measured data are only displayed in zoomed form. Here, the measurement is really made at this higher resolution!*

Center

10 kHz

Set to 10 kHz (= center frequency of difference tone signal)

Span

2.49 kHz

Select 2.49 kHz. This results in an expansion by a factor of 16 (zoom factor). In the graphics window, the zoomed spectrum is displayed (see Fig. 2.5).

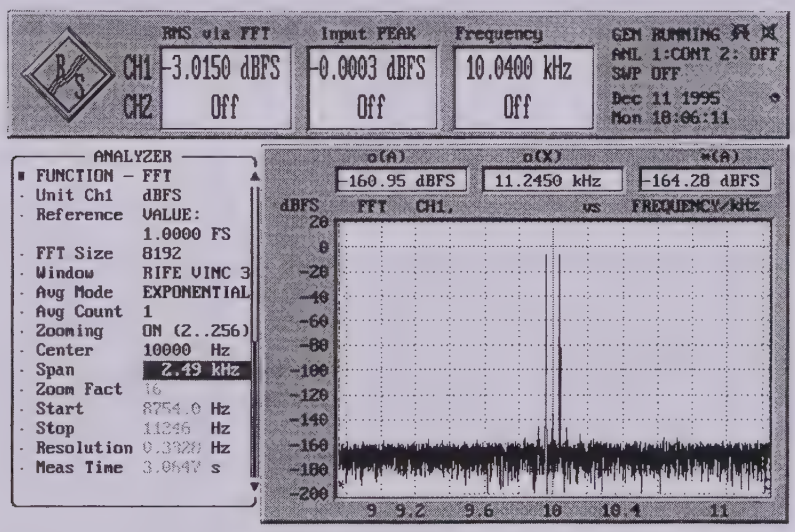


Fig. 2-5

Example 6: Hard Copy of Screen

Span

Use the key in the "Span" line to enter the first column of the panel. The SELECT key is used to tick off this line and generate a copy of this line in the status panel.

STATUS

4

Activate the STATUS panel. In this panel, all lines which have been ticked off by the user in one of the panels are listed. It is thus possible to sum up all particularly important parameters in one panel and to print them out together with the measurement results.

Span

1.37 kHz

The UPL can also be operated from the status panel: select a span of 1.37 kHz (the frequency resolution is increased again).

Essential parameters can thus be modified without changing the panel.

For generation of a hard copy, just connect a printer to the parallel interface and configure the UPL appropriately:

OPTIONS

0

Select the OPTIONS panel.

Destin

Printer

Select hardcopy output to a printer.

Printname

xxx

Select the appropriate printer driver from the list provided. Subsequently, change to the type of display which is to be printed (e.g., activate status panel again).

HCOPY

A box is displayed which allows for selection whether and which comment is added to the printout. Upon acknowledging the request, the printjob is started.
It is advisable with fast printers, to stop the measurements by pressing the STOP key thus increasing the printwork.

2.3 General Instructions for Use

The UPL is very easy to operate, especially when you observe the following recommendations:

- **First select the instrument (both generator and analyzer)**

  Reason: An individual set of parameters is provided for each instrument. This parameter set is saved when changing the instrument and restored when returning to the instrument. It must be loaded first before beginning to make new entries. When changing an instrument, the current choice of functions may change also (e.g., analog instruments do not offer selection of the sampling rate..).

- **Always proceed from "top to bottom" in the panels**.

  Reason: Variations in parameters of individual menu items may affect the selection or the range of values of menu items further down, however not of menu items above.

- **Edit the DISPLAY panel only after the generator and the analyzer have been set**.

  Reason: Everything which can be displayed graphically also depends on the selected measurement function.
  Many setting parameters of the DISPLAY panel are automatically adopted from other panels, if desired, eliminating the need for setting display parameters.

General Hints as to Mouse Operation

If a mouse is connected to the UPL (see Section 1.1.7 Connecting a Mouse), an arrow the position of which can be changed by moving the mouse appears on the screen. The arrow can be moved across the entire screen. If the cursor is on the desired position, the action (see the following Section) is always triggered by pressing a mouse key (= clicking on a field).

Further, the mouse can be used to

- select between the three different display modes:
  3-panel display, part display and full display, with the left and right mouse key being pressed simultaneously in the shaded area (cf. Fig. 2-6, a and c). The mouse click to change the display modes must be at a position in the panel which is not assigned by an operable field.
- change between panel and graphics in the part display, with the left mouse key being pressed in the shaded area (cf. Fig. 2-6 b).
- change the panel by clicking the panel heading using the left mouse key (cf. Fig. 2-6 d).
- entry of file names, comments etc. is easier than via the front-panel keypad. If no external keyboard is connected, a "screen keyboard" is displayed. Its keys can be actuated by selecting them using the mouse.

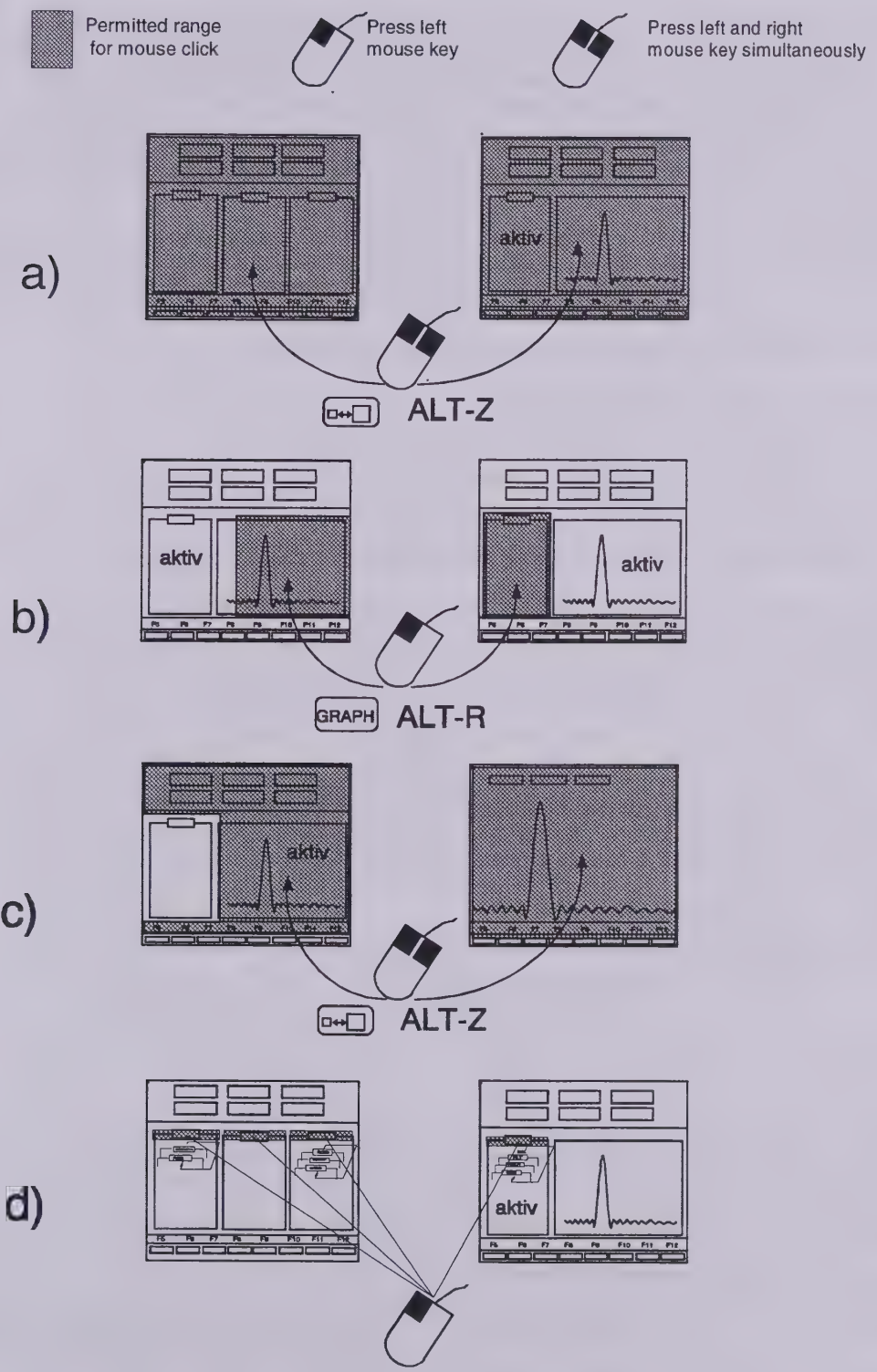

Permitted range for mouse click
Press left mouse key
Press left and right mouse key simultaneously
a)
aktiv
ALT-Z
b)
aktiv
aktiv
GRAPH
ALT-R
c)
aktiv
ALT-Z
d)
aktiv

Fig. 2-6

2.3.1 Panels

Related settings and functions are always combined to form a so-called panel in the UPL. Each panel has a name (= heading in the upper margin of the panel), which is used to call the panel.

In addition to the panels, there is another window in which the measurement results are displayed graphically. Selection and activation of this graphics window matches that of a panel, which is just larger than the panel.

Only one panel can be active at one time. An active panel is characterized by the cursor (field in inverse display) being placed in it, i.e. entries can be made only in this panel. On the whole, there are eight panels (incl. graphics window), a maximum of 3 panels being displayable on the screen at one time.

A panel is selected and, if required, displayed on the screen using

- the panel keys on the front panel
- the short-key combinations of the external keyboard (option)

Switchover between visible panels is also possible by:

- the Tab →, Tab ← keys.
- moving the mouse cursor (arrow) to the desired panel and clicking on a field
- the short-key combination of the external keyboard (option) (see table 2-1).

When a panel is called, the position of the cursor matches that at the time when the panel was left (exception: changing the panel using the mouse; in this case the position of the mouse cursor is relevant). Thus, you can quickly switch between constantly recurring input points.

The keys on the front-panel keypad named DATA/PANEL are assigned two functions. The first is the fast selection of the panels (see Table 2-1), the second function is that of a input block for numbers. Switchover from first to second function and vice versa is made automatically. If the UPL expects the entry of figures (after having pressed the SELECT key with the cursor placed on a field for the entry of numerical values, see Section 2.3.2 Data Entry), the keys serve as figures keys, otherwise as keys for panel selection. If the entry of data is expected, the LED above the designation DATA lights up.

Table 2-1 Panels and their functions

Panel name	Front panel key	Key combination ext. keyboard	Function
Analyzer	ANLR	Alt-A	Settings of all six analyzers
Generator	GEN	Alt-G	Settings of all five generators
Filter	FILTER	Alt-T	Filter definitions of the analyzers
File	FILE	Alt-F	Loading and storing of traces and lists, editing of files and directories
Display	DISPLAY	Alt-D	Parameters for graphical presentation of measurement results
Status	STATUS	Alt-S	Summary of user-definable menu items of any panel
Options	OPTIONS	Alt-O	Settings for printer/plotter, ext. keyboard, ext. monitor, information on options fitted, calling of calibration routines
Graphics	GRAPH	Alt-R	Activates panel or graphical display (toggle function)
Full-screen/part-screen	□◄►□	Alt-Z	Switching from full-screen to part-screen mode (toggle function)

Note: *For a complete list of short-key combinations for operation via an external keyboard, refer to Section 2.1.1, Front-panel View or to the HELP menu under UPL (HELP key or F1 of the external keyboard).*

Every panel has a fixed position on the screen (except when part-screen mode is simultaneously selected, see the following Section):

Position on the screen		
left	center	right
Generator	Analyzer	Filter
File		Display
Status		Options
——— Part-screen ———		
——— Full-screen ———		

The GRAPH key allows you to switch from the active panel to graphical display and vice versa.

The □◄►□ key is used to change from full-screen mode (graphics over the entire screen or 3-panel display, depending on whether graphics or a panel is active) to part-screen mode (a panel by the side of graphics) and vice versa.

In part-screen mode, the panel used most recently moves to the left side of the screen. Any subsequently called panel is placed on this position, too, allowing the user to display and print any panel (especially the → STATUS panel) together with the graphical presentation of results at one time.

After the part-screen mode has been switched off, the current panel is reshifted to its normal position.

Scrolling in the Panel

If a panel has more lines than can be displayed on the screen section, the↑, ↓, Page↑ and Page↓ keys (or the corresponding keys on the external keyboard) can be used for scrolling in the panel. The bar in the right-hand margin of each panel stands for its complete size, the dark section representing the section currently visible on the screen. Arrows show you in which direction to scroll to cause the lines not visible to be displayed in the window.

With the mouse connected, the panel contents is scrolled by one line whenever the respective arrow is selected. Pressing and holding down the mouse key causes the contents to be scrolled until the key is released. Any desired panel section can be made visible by selecting the dark part of the bar and positioning it appropriately by moving the mouse with the key held down.

STATUS Panel

This special panel can be called only in part-screen mode. Any line in any panel can be marked with a tick in the first column (select the position using the Tab ←, ↑ and ↓ keys, press SELECT, the tick is switched on or off (toggle function)). Each marked line is taken over into the so-called STATUS panel, thus allowing the user to sum up all important parameters in one panel. It can be simultaneously displayed with the measurement results and their graphical representation, which is of particular interest for the documentation of results (see 2.8 STATUS Panel).

The UPL can be operated from the STATUS panel as well as from all other panels, thus allowing you to execute any repetitively used control sequence from one panel only.

Changing an Instrument

The UPL has three analyzers (one in each of the measurement ranges 22 kHz and 110 kHz for the measurement on analog interfaces, three for the measurement on digital audio interfaces). All analyzers are set in the ANALYZER panel. The generators are set correspondingly in the GENERATOR panel.

Each of these instruments has its own data set, each with a different structure. The data sets are different with respect to

- the selection of the displayed menu items (= lines of the panel). All settings possible for the selected instrument (e.g., of the analyzer for analog interfaces and the frequency range up to 22 kHz), the settings of the other instruments (e.g.. of the analyzer for the digital interfaces) are suppressed, however retained in the background. This ensures fast and convenient operation of the UPL despite the wide variety of possible settings.
- the permissible range of values for the parameters. It is not possible, for example, to set a sample rate in the analyzer "ANLG 22 kHz", however it is feasible in the analyzer "DIGITAL".
- the selection of the functions. To give an example, the analyzer for the frequency range up to 22 kHz is provided with more measurement capabilities than the analyzer for the frequency range up to 110 kHz.

Parameter Link

It may sometimes be required with changing the instrument that the set of parameters which had been set last time is not set, but that the one of the currently used instrument is set instead. This is, e.g., the case when checking converters, if the same measurements are to be performed at the digital interfaces as have been performed at the analog interfaces. The option panel allows for selection, if any parameters of the current instrument are to be set and which ones, i.e., which are not to be overwritten by the loaded data set (see 2.15.8 Parameter Link). If this so-called parameter link is activated, a query box is displayed with changing the instrument where the user can select once again, whether the parameter link is to be carried out or not.

For switching between the instruments, follow the instructions below:

➢ Place the cursor on the input field of the first panel line (= right-hand column of the line named ANALYZER or GENERATOR) using the mouse or the ↑, Page↑ and Tab → keys. Then press

SELECT

press

(or any mouse key or space on the external keyboard). A selection window with a list of all available analyzers or generators will be displayed.

➢ Select an instrument using the ↑ and ↓ keys, rotary knob or mouse and press

ENTER

press

(or any mouse key or Enter on the external keyboard). The selection window is closed and the settings of the "former" instrument are saved. The panel with the menu items and all settings appertaining to the instrument most recently selected is built up anew.

Changing Functions or Parameters

Changing a function (e.g. from RMS to THD measurement or, from sinewave to multi-sinewave generation) is performed analogously to changing an instrument, which is explained above: all menu items including the parameters appertaining to the function are retained. (The frequencies and amplitudes of all multi-sinewaves are still present, even when the frequency and amplitude of the single sinewave have been changed in the meantime).

Also when changing parameters, the menu items not required are suppressed, their parameters are however retained and are available again when they are activated.

Example:
Changing from "OFF" to, for example, "AUTO SWEEP" in the menu item "Sweep CTRL" causes the menu items (=lines) required in this mode "Start", "Stop", "Points" etc. to be displayed together with the parameters set for the most recent sweep. These lines are canceled again, when the sweep is switched off.

Note: *The order of the menu items in the panel is selected such that varying a parameter may induce changes in the lines further down, however never in lines further up in the panel. We advise you to proceed in the given order from top to bottom.*

Parameter Link

It may sometimes be required with changing a function that the set of parameters which had been set last time is not set, but that the one of the currently used function is set instead. This parameter link can be selected in the option panel (see 2.15.8 Parameter Link). If this so-called parameter link is activated, a query box is displayed with changing the function where the user can select once again, whether the parameter link is to be carried out or not.

2.3.2 Data Entry

The cursor (field in inverse display) indicates for which input field an entry is currently expected. The cursor can be moved from one input field to the other using the front-panel keys ↑, ↓, Page↑, Page↓, Tab → and Tab ← or the corresponding keys on the external keyboard. Some fields in the column with the input fields have display function only, the cursor cannot be placed into them. They are displayed in a different color or in a different gray shade. Menu items without input field serve as headings.

Note: *The same menu item may have an input field or just serve as heading depending on the parameters selected in other menu items.*
Note Section 2.3.2.6 Data Input or Output during Measurements

2.3.2.1 Selecting a Parameter

Place the cursor on the desired input field. Press the SELECT key (or the space bar on the external keyboard) or any mouse key to open a selection window containing all parameters appertaining to this menu item. The cursor↑ and cursor↓ keys or the mouse are used to select the parameters. The window is closed again using ENTER (also with external keyboard), CANCEL (or ESC on external keyboard) or by pressing a mouse key. The parameter of the selection window is taken over with ENTER whereas the former setting is retained with CANCEL. Also, the parameter is accepted when selected with the mouse or, the window is closed while the former setting is retained when any point outside the selection window is selected using the mouse.

Note: *The contents of the selection windows are not constant but vary depending on the other settings selected.*
For a list of all key combinations assigned to the front-panel keys of the external keyboard, refer to Section 2.1, Front- and Rear-panel Views. The key combinations are therefore not explicitly specified in the following description.

2.3.2.2 Entry of Numeric Data

Entry using the rotary knob

- Place the cursor on the desired input field using the rotary knob or the cursor keys ↓ or ↑
- press ENTER or move the numerical cursor (= underscore) to the position to be incremented or decremented.
- the color of the current field changes and the rotary knob can be used to scroll the figure.

The digits can be varied only within the range of values specified in the user info line. A warning is audible when the limit values are reached (can be deactivated, see 2.15.2 Beeper On/Off)

After having left the field by one of the keys ↓ , ↑ , PgUp, PgDn, TAB, SHIFT TAB or CANCEL the rotary knob is used to move the cursor up and down the panel.

Sweep parameters (e.g. generator frequency or level) may be incremented or decremented by a user-defined value which is set by specifying the step width of the manual sweep.

Note: *Some settings require other settings in the panel to be varied (example: when changing the reference voltage, all settings referring to this value must be converted). In this case, the complete panel must be rewritten whenever a value is changed, thus slowing down the rotary knob function.*

Entry using the numeric keypad

Position the cursor to the desired input field, press SELECT or any mouse key or a number key on the external keyboard causing a small input window with the current value to be displayed. (The number of digits available in the input window may be higher than that of the input field allowing the user to enter values with a higher accuracy than can be displayed in the panel, if required. After having closed the window the rounded value appears in the panel.)

If the value is to be re-entered completely, simply enter the figure using the numeric keypad. The first pressing of the key automatically deletes the old value. The BACKSP key is used to delete the figure to the left of the cursor during input.

If you wish to change only individual figures, place the numerical cursor on the respective position using the → or ← and enter the desired figure (changing the position of the numerical cursor before the entry of the first figure or deleting a character causes the former value to be retained).

Close the window using

- ENTER: the value entered anew is accepted
- CANCEL: the old value is retained
- Softkeys: the selected unit is set and the value entered anew is accepted
- Clicking with the mouse inside the input window: the value entered anew is accepted
- Clicking with the mouse outside the input window: the value entered anew is not accepted

Entries outside the specified range of values are not accepted, a warning is audible (can be switched off, see 2.15.2 Beeper On/Off) and the entry is changed to the appropriate minimum or maximum value.

Changing the unit at a later date

Place the cursor on the unit field (using Tab → in the numeric input field) causing a softkey line with the units permissible for this menu item to be displayed. The current numeric value is converted for the selected unit by pressing the respective softkey (see also next Section).

2.3.2.3 Using the Softkeys

The softkeys (eight keys at the bottom screen margin) are used for the entry of units and operation of graphical display. The MORE softkey switches to further softkeys available to this operating point, the BACK softkey returns to the next higher softkey level.

The softkeys can be activated

- using the front-panel keys
- using the function keys on the external keyboard specified in the softkey labeling
- by mouse click.

2.3.2.4 Help Line

The help line is between the panels and the softkeys and always refers to the input field marked by the cursor. It provides you with information on which keys to use for further operation or the permissible range of values. Entries outside the specified range are not accepted, a warning is audible and the entry is replaced by the appropriate minimum or maximum value.

Note: *The maximum permissible range of values may depend on other settings, i.e. is not constant. For further information on the current menu item, press the HELP key.*

2.3.2.5 Entry of File Names

Position the cursor on the input field of the menu item the file name of which is to be changed and press the SELECT key. A dialog window consisting of three more windows will be displayed.

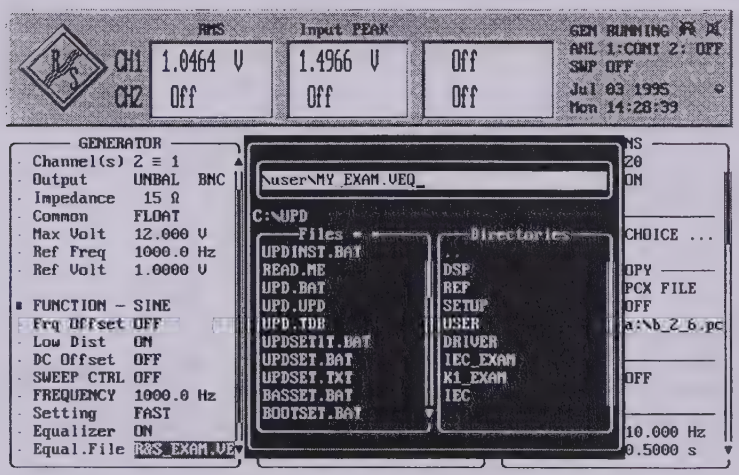


Fig. 2-7

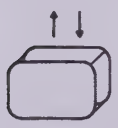
- The top window serves for editing the file name (incl. path name, if required). When selecting the dialog window, it is preassigned with the current file name of the selected menu item. The line below indicates the currently used path (disk drive and directory, see also paragraph "Working Directory").
- The "Files" window allows you to select an already available file. This window lists all files contained in the current path of the file type provided as standard for this menu item. (The type of file is identifiable by the three letters after the point. Different types of files are used for the different tasks of a file (e.g. limit file, sweep list file etc.) to facilitate file management. For a list of all types and their meanings, 2.9.1 Loading and Storing).

➢ The "Directories" window allows the user to change the directory. It contains the subdirectories (if any) of the current path. The directory name "..." represents the higher-order directory with respect to the current directory.

The Tab ← and Tab → keys can be used to switch between the above windows.

Selecting an already available file

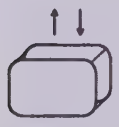
Change to the Directories window using the tab key in the open dialog window.



Select the desired directory. Scrolling is possible as in a panel, also with the help of Page ¬ (see Section 2.3.1 Panels)

ENTER

The newly selected, current path is displayed, the window contents are UPLated, *.xxx is entered as file name, where xxx stands for the type of file provided as standard for the selected menu item.



Change to the Files window and select the desired file.

ENTER

The selected file name is taken over into the input window where it can still be modified (see below "Entering a new file name"). Entering an already available file name is to be preferred, in particular when no keyboard is used as entering a completely new name is then time-consuming.

ENTER

Close the dialog window, storing or loading is effected with the name stated in the input window. CANCEL closes the window without any operation carried out, the old file name being retained.

Entering a new file name

➢ Change to the uppermost window.
The file name to be entered must comply with the MS-DOS conventions: a maximum of eight characters followed by a point and the data type consisting of a maximum of three characters. The <> = , ; : . * ? [] () Λ + ! characters must not be used.

There are three ways of entering the file name:

- using an external keyboard
- with the help of the mouse (also with no external keyboard connected)
- via the front-panel keypad

For entries without using an external keyboard, place the input cursor (" /\" character) on the position there characters are to be entered using the → or ← key. Press the mouse key or the SELECT key. A selection window with all characters which can be entered will be displayed. Select a character (using the mouse or →, ← keys), which is then inserted into the file name at the cursor position whenever a mouse key or the SELECT key is pressed. An entry at the first position causes the former file name to be automatically deleted. BACKSP is used to delete the character to the left of the input cursor. Close the selection window using the ENTER key, by selecting <ok> in the selection window or by selecting one of the three windows in the dialog window with the help of the mouse.

When using an external keyboard, editing is made directly in the input window, the above selection window with the alphabet is not displayed. On **power-up**, the UPL checks whether an external keyboard is connected. (Being not initialized when connected after power-up of the UPL, the key-board does not function properly.)

The following can be entered in the input window (see also previous section "Working Directory"):

- File name without path specification: The path specified in the next line is used. Storing and loading is initiated using ENTER.
- File names with wild cards (don't care characters * and ?). ENTER serves to display the respective files in the FILES window, e.g. *.LUP is used to list all files of this type. The search for file types other than the standard files is thus possible.
- Only a path. The path and window contents are correspondingly updated.
- File name incl. the complete path specification. Storing and loading is initiated using ENTER.

Using the Working Directory

Files can be summed up in a working directory for certain projects or instrument users (see Section 2.9.1 Loading and Storing). The path specified in the menu item WORKING DIRECTORY of the FILE panel (e.g. C:\PROJECT1) precedes all file names used in the UPL at the time of loading or storing, provided they do not begin with "\" or "Drive:\".

Example:
Entering the file name MEAS5\MYFILE.XYZ results in the path C:\PROJECT1\MEAS5\MYFILE.XYZ, to use the above example again.

2.3.2.6 Data Input or Output during Measurements

Internal or external sweep switched off

(**External sweep:** The parameter AUTO is not selected for menu item START COND of analyzer)
All entries are permissible at any time. After having terminated an entry (ENTER), the present measurement or output is aborted, the newly selected parameters are set and the measurement or output is restarted.

Note that with graphical display (e.g. continuous FFT, bargraph, histogram of intermodulation measurement), the graphics output is interrupted when a selection window is opened, however the measurement continues. After having closed the window, the graphics is restored, or, when display parameters were changed, the graphics is deleted and built up again with the new settings (in the case of continuous FFT, this is performed only at the end of the present FFT).

Internal or external sweep switched on

(**External sweep:** The parameter AUTO is not selected for menu item START COND of analyzer)
Any entry causes the sweep to be stopped (i.e. it is stopped after conclusion of the current sweep) and then the action initiated by the activated key to be executed because modifications to parameters during a sweep may affect the measurement, thus rendering the measurement results displayed on the screen questionable.

Exceptions:

The following keys can be activated or the following actions can be made without aborting a sweep:

- Entries in the DISPLAY panel
- Display of any panel without varying parameters
- Rotary knob (enables a manual sweep, (see 2.5.4.2 Sweeps)
- Softkeys of graphical display of results

Changes in the GENERATOR, ANALYZER, FILTER or STATUS panels cause the internal instrument status to be set to "measurement invalid" because the measurement results do not match the setting parameters. The attempt to save or print these measurement results is prompted by an appropriate warning (see Section 2.9.1 Loading and Storing and Section 2.14 Printing/Plotting/Storing the Screen Contents (OPTIONS Panel)). It is no longer possible to continue the sweep using the CONT key, a restart with the START or SINGLE key is required.

Modifications to parameters in the DISPLAY, FILE and OPTIONS panels do not affect the measurement results; the internal instrument status is "measurement valid". Entries are immediately processed. (Exception: With continuous FFT, modifications to the display parameters are considered only in the next spectrum to be output). The measurement can be continued with the CONT key.

Note: *See also 2.11 Starting and Stopping of Measurements or Sweeps*

2.3.3 Display of Measured Values

The display windows for a maximum of 6 measurement results are in the upper section of the screen except for in full-screen mode.

To the right of the windows, there are status information on the current instrument state, see 2.3.5 Status Display.

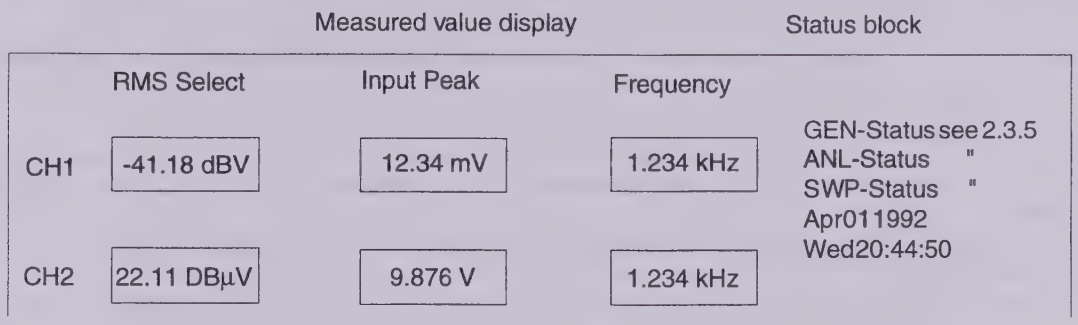


Fig. 2-8

1st column: Measurement results of the selected measurement functions ...

2nd column: Measurement results of the measuring function selected in menu item „Input Disp" (in the example, peak value display of input levels) ...

3rd column: Frequency and phase measurement results ...

... each for both channels at one time.

Display of measured values:

1.234 V	The measurement results are shown in 3 ½-, 4 ½- or 5 ½-digit display i.e. the decimal point jumps at the transition 2.999 ↔ 3.00, 29.99 ↔ 30.0, 299.9 ↔ 300 etc. If a measured value happens to be in the transition range, hysteresis prevents an unsteady display. The number of digits and the rate of updating the displayed measurement results can be selected in the option panel - depending on the measurement function (see 2.6.5 Functions). Independent of this reading rate, the measurement rate can be selected for the individual functions (see 2.6.5 Functions). Only the function influences the measurement accuracy. With fluctuating measurement results it is advisable to reduce the number of digits to be displayed (reading resolution) in order to obtain a steady display. The measurement results can be displayed with various units individually for each channel. The unit is selected in the analyzer panel with the measurement function.
OFF	The measurement channel or function is OFF, for example, Input Peak = OFF
- - - -	There is no measurement result related to the selected function available, e.g., there are no frequency measurement results during DC measurements.
-INPUT ?- Press SHOW I/O	The measurement result cannot be displayed because of an inappropriate input signal. A hint about how to eliminate the error appears when pressing the SHOW I/O key (see 2.6.3).

2.3.4 Settling Process

2.3.4.1 Introduction

Why settling is necessary:

If a modification is made at the generator of the UPL and if the settling time of a test item is known, it can be considered using the delay indication in the analyzer panel (cf. 2.6.4 Ways of Starting the Analyzer, Ext. Sweep). Settling processes within the UPL are automatically considered so that the user does not need to take these times into account. The analyzer supplies settled, valid measurement results.

If there is a test item with an unknown transient response between the generator and the analyzer of the UPL or if a test item is fed by an external generator, a transient response will usually be observed at the measurement result after a change of the signal or a manipulation at the test item (in the case of a high measurement rate compared to the settling time) until the display has stabilized. The steadied readout is then accepted to be valid.

The settling process in the UPL has the aim of imitating and automating this procedure. A measured value is only output if it satisfies a certain accuracy the user can enter freely (maximal deviation from the settled final value, later the expression "tolerance" is used). The settling process is preferably used in cases where measurements are to be made at test items with an unknown or changing settling time. The settling process can be combined with a delay so that an undesired signal characteristic can be ignored before the settling process begins as of the starting time of the measurement (change of generator or of signal with external sweep). The settling process can also be used to steady the readout by rejecting values which do not comply with the accuracy entered.

How the settling process is realized:

The value measured by the UPL is permanently compared with up to 5 measured values stored immediately before. A measured value is only accepted as valid if it is within the tolerance limits entered by the user with regard to the previous measured values. Otherwise it is rejected and included in the series of comparison values for the next measured value.

Where settling can be set:
The settling process can be applied to:

- External sweep (START COND → FREQ CH1 | FREQ CH2 | VOLT CH1 | VOLT CH2)
- Frequency results (FREQ/PHASE → FREQ)
- Phase results (FREQ/PHASE → FREQ&PHASE)
- Function results for all functions except for FFT, POLARITY and WAVEFORM (START COND → AUTO)

The settling process for the external sweep and the settling process for the frequency, phase or function measurement can be combined.

> **Exception:**
> Settling process in combination with external sweep with a change of the frequency as trigger condition (setting START COND → FREQ CH1 | FREQ CH2) cannot be combined with a settling of the frequency results. Reason: There are already settled frequency results which do not have to be weighted using a settling process again!

All settling settings can be activated in the ANALYZER panel in the corresponding panel sections under menu item "Settling".

2.3.4.2 The Settling Parameters:

The appropriate settling parameters are stored for every measurement function so that the settling settings once selected and well tested are effective in a change of the function.

Settling:

Settling → EXPONENTIAL

sets a result comparison window with an exponential characteristic whose lock-in range is determined by the setting "tolerance". This setting is ideal for measurements on test items with a normal exponential transient response and usually covers most applications (cf. Fig. 2-9).

Settling → FLAT

sets a result comparison window with a fully flat characteristic (tolerance band) whose lock-in range is determined by the setting "tolerance". With a very small tolerance entered, this setting only supplies a measurement result if the test item has quasi completely settled. Due to this stricter settling condition, the time until a valid measured value is recognized is usually longer than with the EXPONENTIAL setting (cf. Fig. 2-9).

Settling → AVERAGE

causes an arithmetic averaging for the number of measured values set in samples. After a restart of the measurement by pressing the SINGLE key at the UPL or a parameter entry which must result in a restart of the measurement such as modifications of the generator signal or of the settling parameters themselves, the average is only output when the number of measurements set by means of "samples" has been made. If the memory is full of measurement results, the most previous result is dismissed and the average output with every new result. In this phase, an abrupt change of the signal results in a creeping change of the average (low-pass properties).

Samples:

This value indicates the number of measured values used for tolerance and resolution comparison. Samples = 6 means that the latest measured value is compared with the 5 last measured values.

Tolerance:

The tolerance value denotes the maximally permissible deviation from the previous measured value a settled measured value may have in order to be classed as valid by the UPL. The value of the maximally permissible deviation of the current measured value compared to the 2nd/3rd/4th and 5th last measured value is determined by the EXPONENTIAL | FLAT setting.

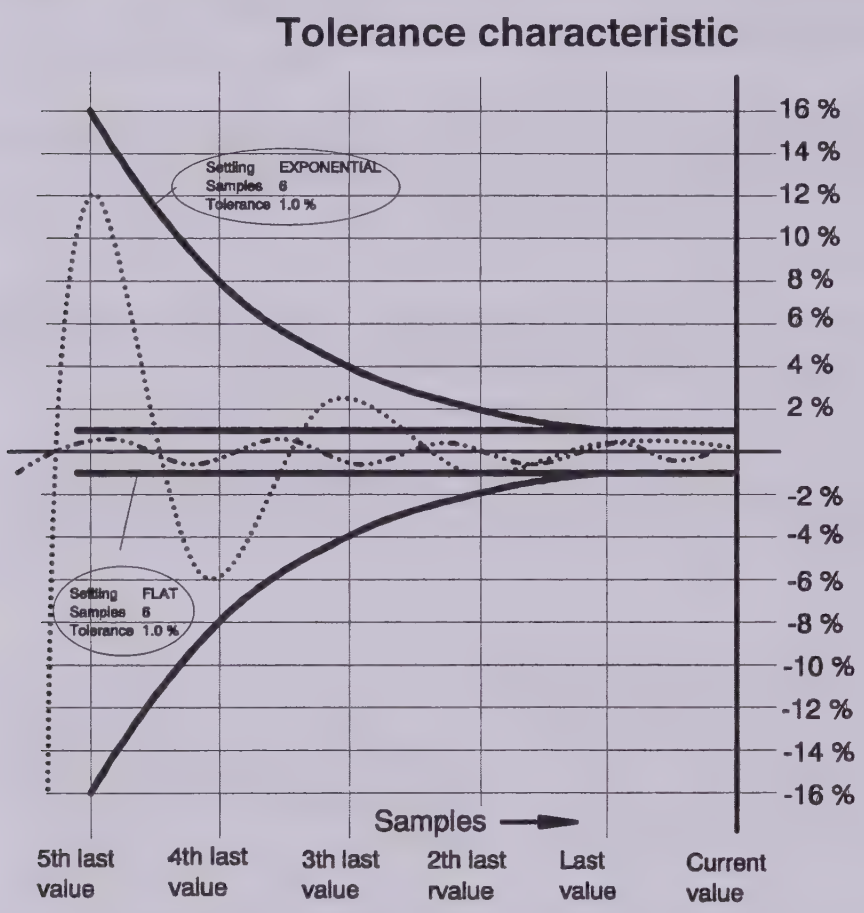


Fig. 2-9 Tolerance characteristic

When the measured values are checked as to whether they satisfy the tolerance condition,

- volt is always used as a basis for the measurement result for level measurements RMS & S/N, RMS SELECT, PEAK & S/N, Q PK & S/N and DC,
- % is used as a basis for the measurement result for intermodulation measurements THD, THD+N/SINAD MOD DIST, DFD and WOW & FL, and
- Hz is used as a basis for the measurement result for frequency measurements, irrespective of the unit in which the measurement result is displayed.
  For a phase measurement, it is only possible to set the resolution (see resolution).

Examples:

In the following examples, Settling → EXPONENTIAL and samples = 6. If the tolerance is 1%, this means that the current measured value must be identical to

- the last measured value ±1% (or ±0.086 dB)
- the 2nd to the last measured value ±2% (or ±0.172 dB)
- the 3rd to the last measured value ±4% (or ±0.340 dB)
- the 4th to the last measured value ±8% (or ±0.668 dB)
- the 5th to the last measured value ±16% (or ±1.289 dB).

Level measurement, tolerance 1 %:

A measured value of 1 V is displayed as settled, when

- the	last measured value is between	0.99 and 1.01 V (±1%)
- the 2nd	to the last measured value is between	0.98 and 1.02 V (±2%)
- the 3rd	to the last measured value is between	0.96 and 1.04 V (±4%)
- the 4th	to the last measured value is between	0.92 and 1.08 V (±8%)
- the 5th	to the last measured value is between	0.84 and 1.16 V (±16%)

Intermodulation measurement, tolerance 1%:
A measured value of 0.01 % is displayed as settled, when

- the	last measured value is between	0.0099 and 0.0101 % (±1%)
- the 2nd	to the last measured value is between	0.0098 and 0.0102 % (±2%)
- the 3rd	to the last measured value is between	0.0096 and 0.0104 % (±4%)
- the 4th	to the last measured value is between	0.0092 and 0.0108 % (±8%)
- the 5th	to the last measured value is between	0.0084 and 0.0116 % (±16%)

Intermodulation measurement, tolerance 0.1 dB (1.16 %):
A measured value of -80 dB (0.01%) is displayed as settled, when

- the	last measured value is between	-80.1 and -79.9 dB (±1.16%)
- the 2nd	to the last measured value is between	-80.2 and -79.8 dB (±2.32%)
- the 3rd	to the last measured value is between	-80.4 and -79.6 dB (±4.63%)
- the 4th	to the last measured value is between	-80.8 and -79.2 dB (±9.26%)
- the 5th	to the last measured value is between	-81.7 and -78.5 dB (±18.53%)

Frequency measurement, tolerance 1 %:
A measured value of 1000 Hz is displayed as settled, when

- the	last measured value is between	990 and 1010 Hz (±1%)
- the 2nd	to the last measured value is between	980 and 1020 Hz (±2%)
- the 3rd	to the last measured value is between	960 and 1040 Hz (±4%)
- the 4th	to the last measured value is between	920 and 1080 Hz (±8%)
- the 5th	to the last measured value is between	840 and 1160 Hz (±16%)

Resolution:

With very small measured values, especially at the lower measurement limit of the UPL, or in the case of signals with superimposed noise, relatively large measuring errors may occur so that the measured value often is no longer within the exponential tolerance characteristic. In this case, a minimum value of the result resolution is considered, the "resolution" value, which serves as the starting value for an exponential resolution characteristic and which has exactly the same curve (EXPONENTIAL or FLAT) as the exponential tolerance characteristic (see fig. 2-10).

A value outside the exponential tolerance characteristic which has been caused by superimposed noise is not expressive with regard to the transient response of the test item. If the measured value satisfies the resolution entered by the user, however, it is accepted as being valid nevertheless.

If, e.g., the current measured value is not within the tolerance limit required compared to the 4th last result, the amount of the difference between the current measured value and the 4th last value is found and compared to the resolution value no. 4. If this difference value is smaller than the resolution value, the measurement result is considered to be valid.

The accuracy of the phase measurement results is the same throughout the entire range from 0 to 360°. Observing the tolerance for phase measurement results would not be very useful, because the slightest phase fluctuations about 0° would cause large tolerance jumps and thus continuously violate the tolerance conditions. Therefore, only specification of the resolution is possible for the phase measurement, i.e. the absolute offset of the current phase measurement result compared to the previous phase measurement results in °.

Example:
Phase measurement with resolution 1°:
A phase result is indicated to be valid if the magnitude of the difference between the current measured value and

- the last measured value < = 1°
- the 2nd last measured value < = 2°
- the 3rd last measured value < = 4°
- the 4th last measured value < = 8°
- the 5th last measured value < = 16°

Example by means of the following panel setting:

Settling	EXPONENTIAL
Samples	5
Tolerance	1.0 %
Resolution	0.5 mV

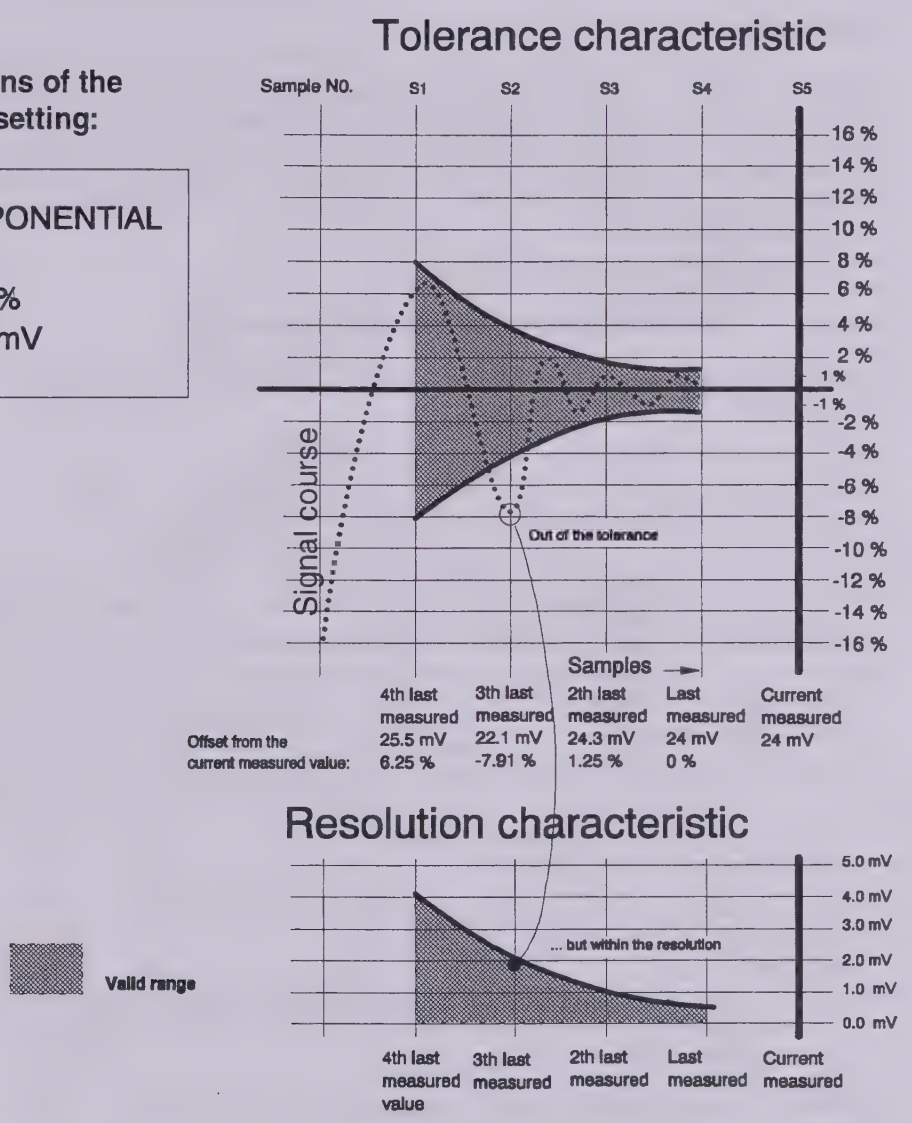


Fig. 2-10 Connection between tolerance and resolution

The EXPONENTIAL traces are always calculated to the basis 2. The sampling points of the exponential tolerance characteristic, e.g. starting from tolerance 1%, are calculated to: 1%, 2%, 4% and 8%. The sampling points of the resolution trace, e.g. starting from a resolution of 0.5 mV, are calculated to: 0.5 mV, 1 mV, 2 mV and 4 mV. The offset of the current measured value compared to the 3rd last measured value is -7.91% and is therefore not within the desired tolerance. When the amount of the difference between the current measured value (24 mV) and the 3rd last measured value (22.1 mV) is smaller than or equal to the resolution value [S2] (2 mV), the current measured value is accepted as being valid nevertheless.

$|24\ mV - 22.1\ mV| = 1.9\ mV$
Since 1.9 mV < 2 mV, the current measured value is valid.

Time-out:

Time-out denotes the time which may elapse from the start of a measurement until the settling mechanism has recognized a settled measurement result. If the measured value does not stabilize within this time, the measuring loop is aborted and the note "Input - Press SHOW I/O" output instead of a measured value. During a sweep with a graphical curve display, a gap in the curve trace indicates that a measured value is missing. In the case of settling with an external sweep (cf. next paragraph) a time-out is not considered.

2.3.4.3 Settling Process with External Sweep:

For better understanding the following explanations, please read menu items
- "Min VOLT"
- "Start"
- "Stop"
- "Variation"

in Section 2.6.4, Ways of Starting the Analyzer, Ext. Sweep

When the external sweep (START COND → FREQ CH1 | FREQ CH2 | VOLT CH1 | VOLT CH2) is used together with the settling process, the following measurement procedure results (see fig. 2-11):

1. Check whether a level of at least the value indicated in "Min VOLT"is present at the measurement input. (Only true of an external sweep with triggering on frequency changes (START COND → FREQ CH1 | FREQ CH2)
   No: Execute step 1.
2. Wait for the stabilization of the frequency with setting: _START COND → FREQ CH1 | FREQ CH2, or
   the stabilization of the level with setting: START COND → VOLT CH1 | VOLT CH2
   by means of the settling process.
3. Check whether the level or the frequency are in the range indicated by "Start" and "Stop".
   No: Execute step 1.
   Yes:- Wait the time indicated under delay to permit a test item to settle.
   - Execute function measurement (possibly including function settling)
   - Proceed function result to the display
4. Check whether a change in level or frequency by at least the value indicated in "Variation" has occurred.
   No: Execute step 4
   Yes: Execute step 1

Note on the delay:

A delay with an external sweep with settling process is useful when measurement is carried out on test items showing a slow transient response of the level due to a change in frequency (e.g. hearing aids with sound-level limiter or compander/expander circuits with fast level rise times and slow decay times). A frequency change has to be set as a trigger condition (START COND → FREQ CH1 | FREQ CH2). If the settling mechanism supplies quickly steadied values for the frequency results but the level is far from having stabilized, the lapse of the level settling time can be waited for using delay.

External sweep with settling process example:

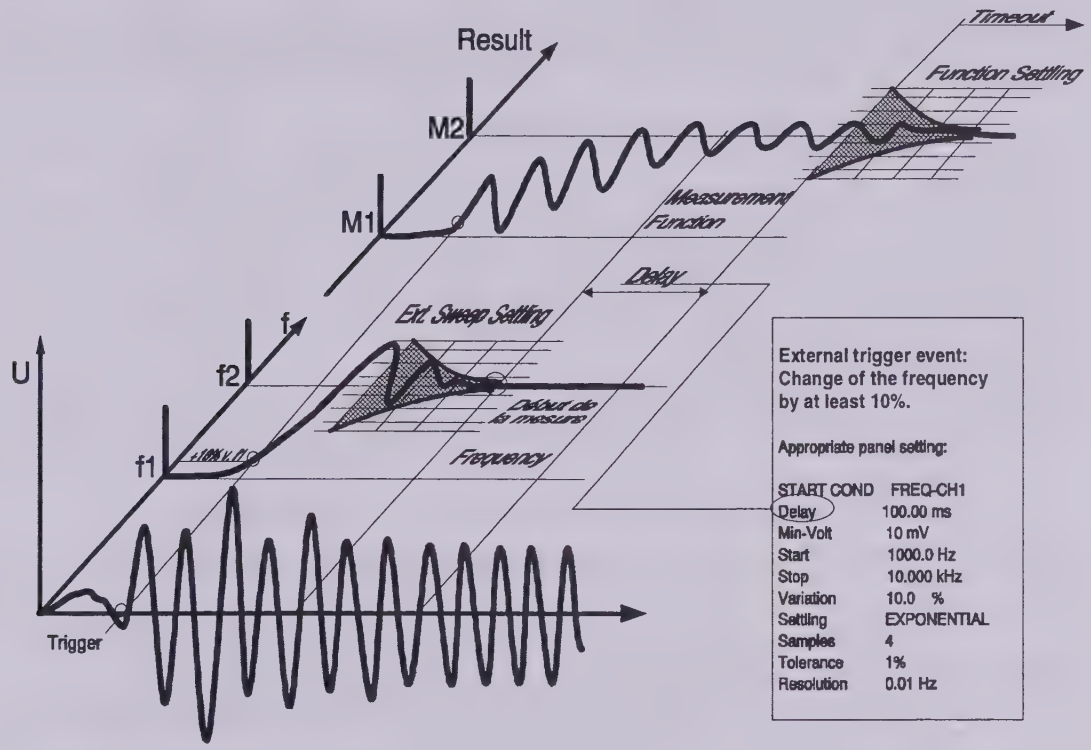


Fig. 2-11 External sweep with settling process

2.3.4.4 SETTLING Check and Optimization

Settling check

If the SHOW I/O key is pressed during a fault-free measurement run with activated settling process, the settling control characters "r", "t" or "-" appear in a suggested result window or after the text "Ext. Sweep", indicating whether the result display or the trigger event were possible because of a fulfilled tolerance or resolution condition. According to this display, the tolerance or resolution value can be varied until the desired transient response is achieved.

Example of an indication in SHOW I/O display:

	Func		Freq
CH1	rtttr		rrt
CH2	ttttr		ttt

Ext. Sweep: trt

Explanation:

"**t**": tolerance condition fulfilled
e.g., "t" at the third position: tolerance condition of the current measurement result compared to the 3rd last measurement result was fulfilled.
"**r**": resolution condition fulfilled, only
e.g., "r" at the fifth position: the tolerance condition of the current measurement result compared to the 5th last measurement result was

n o t fulfilled, the resolution condition was fulfilled instead.

Exception:
Since no tolerance condition can be specified for the phase measurement, a settled phase measurement result is always characterized by "r".

"**-----**": No settled measurement result.
Remedy:
- Increase tolerance and resolution value
- Reduce the number of samples
- Switch from FLAT to EXPONENTIAL.

"rrrrr" The measurement result is too unsteady or noisy for the selected tolerance condition.
Remedy:
Select greater tolerance value.
If a still smaller resolution value was selected, "-----" would be displayed.

"rttrt" The measurement result is still too unsteady or noisy for the selected tolerance value.
Remedy:
The more unsteady this display, the greater the tolerance value to be selected.

"ttttt" The measurement results lie all inside the specified tolerance range.
The tolerance condition can be tightened by using a smaller tolerance value or the setting Settling → FLAT until an "r" appears sporadically.

Note: *If varying or fluctuating measurement results are to be observed although the tolerance condition is fulfilled, this may be due to the following reasons:*
- *Slowly rising or falling measured values (compared to the measurement rate)*
- *Sudden, but rare variation of the measured values compared to the measurement rate.*

Optimizing the settling parameters:

In order to obtain maximal measurement rates in connection with the settling mechanism, the DELAY time under START COND → AUTO (cf. 2.6.4) is to be observed. This is the time elapsing from the setting of the generator until the restart of a measurement (and thus the start of the settling process) in order to take into account possible dead times of a test item. The UPL automatically considers the settling time of the generator and the analyzer. If the value 0.0 s is entered for DELAY, no additional delay is effective and a maximum measurement rate is achieved.

As the settling process in the UPL can be used for individual measurements, the suitable settling parameters can be easily determined by observing the measurement results and by trying.

Delay value if the UPL generator is used

Measurement of the DUT delay using the time-controlled measurement functions Timetick or Timechart (START COND → TIME TICK or TIME CHART, cf. 2.6.4 Ways of Starting the Analyzer, Ext. Sweep) and graphical display. After a generator modification, determine the time until the sudden signal change.

Delay value with external sweep

In the case of unknown signals, short dead times of the test item up to approx. 100 ms can be determined using function WAVEFORM, for longer dead times we recommend to use a storage oscilloscope. If test bands, test CDs etc. are used, possible manufacturer's instructions can be used. Trying delay values for the external sweep is usually not successful since settled measured values might occur, but possibly at an undesired point of time.

Sample value
A high value makes high demands on the transient response of the test item. No general statements possible.

Tolerance value
Select bar display until the min/max values are within the desired limits. A tolerance indication of 1% is suitable for most AF applications. In the case of noisy test bands with considerable level fluctuations, e.g., the tolerance value must not be selected too small as otherwise settled measured values would never be obtained. Tolerance values of approx. 5% with 3 samples can be useful.

If noisy signals are weighted via the settling process, a steadied readout can be achieved by suitably setting "tolerance". However, the measurement rate decreases as possibly very many measured values have to be rejected until the settling condition is satisfied. The settling process offers the possibility of averaging (cf. AVERAGE).

Resolution value
Observe value displayed. The resolution value should always remain near the UPL resolution. If, e.g., the level result fluctuates by 2 mV, a value which is approx. 5 times higher, i.e. 10 mV, would be suitable as resolution value.

Caution! *Two high a resolution value would permanently signal settled measured values although the tolerance conditions would permanently be violated.*

Time-out
The longest time the UPL takes to measure the test item can be determined by experimenting. If this time is slightly increased, it can be used as time-out period and guarantees a maximal rate of the test run in the case of time-out being exceeded.

Note: *For explanation of how to enter settling commands see 2.6.5.1 Common Parameters of Analyzer Functions.*

2.3.5 Status Display

The status information is always displayed in the top right section of the screen and contains information on the current status of the generator, analyzer and sweep system as well as date and time.

Exception: In full-screen mode (see 2.10.9 Switching between Full-screen and Part-screen Mode), date and time are displayed right-flush in the operator guidance line.

Status display GEN Status

GEN OFF:	Both generator channels are off.
GEN RUNNING:	Generator outputs signal.
GEN BUSY:	Generator-DSP is temporarily processing the waveform.
GEN HALTED:	No generator output signal because of the setting not yet concluded or invalid.
GEN OVERRUN:	The sample rate applied to the external input (see 2.5.3) is too high for the selected digital generator. Remedy: • Set a lower external sample rate. Recall the function.

Status display ANL Status

ANL WAIT FOR TRIG: The analyzer waits for the trigger condition set under START COND (see 2.6.4).

ANL1: 2:

Separate status information for analyzer channels 1 | 2:

OFF:	Channel OFF, no status messages
OVER:	Overranges may occur when • a measurement range has been fixed using FIX (see 2.6.2 Configuration of the Analog Analyzers) • a signal with a level featuring a crest factor > 2 is applied to the range limit • DC control is applied to the input configuration BAL.
UNDR:	Unterranges may occur when a measurement range has been fixed using FIX or LOWER (see 2.6.2 Configuration of the Analog Analyzers)
RANG:	Ranging. No measurements possible!
SNGL:	Single measurement running
CONT:	Continuous measurement running
TERM:	Single measurement terminated
STOP:	Measurement stopped
CAL:	Cyclic internal DC offset calibration of A/D converter in the analog analyzers or DC offset calibration of input levels in measurement function DC. Calibration, see 2.15.6.
ORUN:	The sample rate applied to the external input (see 2.6.3) is too high for the selected digital instrument. Remedy: • Set a lower external sample rate Recall the function.

(see 2.11 Starting and Stopping Measurements or Sweeps)

Status display SWP Status after modifications to the settings

SWP OFF:	No sweep	see 2.11 Starting and Stopping of Measurements or Sweeps
SWP INVALID:	Sweep invalid because not yet started or parameter varied	
SWP TERMINATED:	Single sweep terminated	
SWP STOPPED:	Sweep was stopped and can be continued	
SWP CONT RUNNING:	Continuous sweep running	
SWP SNGL RUNNING:	Single sweep running	
SWP MANU RUNNING:	Manual sweep running	
SWP UNDERRANGE:	On account of an underrange, valid, yet inaccurate measured values occurred during a sweep.	

Other status displays:

In the section where date and time is displayed, the following status messages are displayed. Data and time are displayed again when the cause for the error has been removed.

PRINTER NOT READY
- After the H COPY key has been pressed, the UPL recognizes that no printer is connected.
- The connection to the printer has been interrupted while files or lists (see **2.14.1** and 2.14.5) are being printed.

CONVERTING SETUP — The setup of a previous UPL program version is being converted to be loadable by the latest UPL program version.

WAIT FOR CAL: ANA OFFSET — The analyzer requires an offset calibration. It is currently not feasible because cyclic DC-offset calibration has been switched off (see 2.15.6) or, due to a running sweep, has been disabled.

The operator guidance line shows the following status message:

DUMP SCREEN TO TEMPORARY FILE — Pressing the H COPY key causes the screen contents to be copied to a temporary file. While this status message is being displayed, operation of the UPL is not possible.

2.3.6 Error Messages

All error messages in manual mode are displayed in a window in the center of the screen until ENTER is pressed.

The error message contains a hint about its recovery, if possible.

Error messages in measurement mode

In measurement mode, error messages may occur on account of inappropriate input signals or settings, thus disabling the display of measured values. Instead, the following hint is displayed in the window:

```
-INPUT ?-
Press SHOW I/O
```

Fulfilling this request by pressing the SHOW I/O key on the UPL front panel (or ALT + I on the keyboard) sets a graphics to show the currently active inputs/outputs (see 2.12) and a text giving information about why the display of measured values is not possible. If there are more than one message, the messages can be called one after the other by repeatedly pressing the SHOW I/O key. Messages issued more than 30 seconds ago are not displayed.

The UPL front-panel graphics is removed and the measurement mode is entered again when

- all messages have been read out and the SHOW I/O key is pressed again.
- CANCEL or ESC is pressed.

Fatal errors with error messages

Just in case an internal software error making it impossible for the UPL program to run should occur, which is never to happen, the DOS operating system is branched to. The following error message will be displayed.

"Save setup to C:\UPL\SETUP\UPL.SET and Exit to DOS!"
"Internal Error No. xxx -- press any key!" where xxx is the error number.

Before returning to the DOS operating system, the current setup and a fault diagnostics buffer including the error number xxx is stored from the battery-backed RAM of the UPL to the hard disk under the name C:\UPL\SETUP\UPL.SET.

You can facilitate troubleshooting for the R&S service personnel by including the UPL.SET file.

To this end, connect a keyboard to the UPL (see 1.1.6 Connecting an External Keyboard), insert a 3½"-disk into the disk drive and enter the DOS command:

```
COPY C:\UPL\SETUP\UPL.SET A:
```

When the UPL is put into operation again after a fatal error, the power-up picture includes the hint
"Error in prev. run! CANCEL → default setting, ENTER → previous setting"
offering you the following possibilities

- CANCEL: ... booting the UPL with its default setting
- ENTER: ... booting the UPL with the previous setting which might be faulty.

Fatal errors without error message

In the case of a fatal error without error message, the UPL was no longer capable of storing the information which provides the above selection box when the UPL is put into operation again. Analogous to the above selection box, you can select between two ways of starting the UPL.

Booting the UPL with the setup most recently stored in the CMOS-RAM

This setup may be correct despite the faulty response of the UPL. To avoid having to re-enter the settings most recently input, try to start the UPL with this setup.

- Switch power switch off and on (no further action necessary).

In case the above attempt fails,

boot the UPL

Enter the following and terminate with ENTER:

UPL -d	The setup "DEFAULT.SET" supplied with the UPL in the directory C:\UPL\SETUP is loaded.
UPL -s	The UPL is started with the setup given without space character following "-s". The file name should be combined with a path name, e.g.: -sA:\SETUP\MYSETUP.SET ODER -sC:\UPL\USER\MYSETUP.SET (The file names are given by way of example.)

2.3.7 Help Function

Calling the HELP function:

UPL front panel

External keyboard

A HELP information can be called for any input field in the panels (context-sensitive). It is displayed in a window in the center of the screen. Depending on the size of the HELP information, waiting times of several seconds may occasionally occur, which is indicated by the note

Just a moment please!

If the HELP information extends the range provided in the window, paging is possible by way of the Page ↑ and Page ↓ keys. A scroll bar at the right margin of the window indicates the position of the visible text section with respect to the complete HELP information. Highlighted fields within the HELP information serve as cross-references for a more detailed description. Cross-reference information is selected using the ↑, ↓, →, ← keys and displayed using SELECT. The HELP window is used and scrolled in the same way as is a panel (see 2.3.1 Panels).

Requesting a HELP information stops the output of graphics.
Measurement results can still be output.

Selection of the language

The help text can either be displayed in German or English language. The languages can be selected in the OPTION panel under the menu item Language (cf. 2.15.4)

Help information on the graphics softkeys:

By calling the help function with active part or full display, the user obtains the help information on the graphics softkeys.

2.4 Units

There are two types of units available in the UPL:

- Units for the display of measurement results:
  Select a display unit for every measurement function in the ANALYZER panel. The measurement result will be displayed with this unit in the measured value window (see 2.3.3 Display of Measured Values). The unit is selected under the menu item "UNIT" of the respective measurement function subsequent to opening the window.
- Units for the input of values (e.g. reference values, frequencies, level etc.). While data are entered, all appropriate units are offered on the softkeys thus enabling termination of the value entry by selection of the unit. Opening of the selection window is not required (cf. 2.3.2.2 Entry of Numerical Data).

2.4.1 Units for the Display of Measurement Results

To simplify the matter

- the data to be entered are designated in the conversion formulae below with their unit, only.
  Example: "dBu" means: value in dBu.
- the conversions into µ, m, k, M are omitted

Units for analog level measurement results:

Functions: RMS & S/N, RMS Select, PEAK, QPEAK, DC, Input-Disp: PEAK, Input Disp: RMS
Basic unit: Volt (V[V])

Table 2-2 Units for analog level measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
V	V	
dBV	DBV	20 * lg (V)
dBu	DBU	20 * lg (V/0.7745967)
dBm	DBM	10 * lg (V^2*1000/R_{REF})
W	W	V^2/R_{REF}
Δ%V	CPCTV	(V/U_{REF}-1)*100
ΔV	DV	V-U_{REF}
V/Vr	VVR	V/U_{REF}
%V/Vr	PCTVVR	100 * V/U_{REF}
Δ%W	DPCTW	(((V^2/R_{REF})-P_{REF}) * 100)/P_{REF}
ΔW	DW	(V^2/R_{REF}) - P_{REF}
P/Pr	PPR	(V^2/R_{REF})/P_{REF}
%P/Pr	PCTPPR	(V^2/R_{REF})/P_{REF} * 100
dB	DBR	20 * lg (V/U_{REF})

R_{Ref} = Value of reference impedance from ANALYZER panel
V_{Ref} = Reference value from ANALYZER panel of functions RMS & S/N, RMS-SELECT, PEAK, QPEAK, DC or Input PEAK/RMS measurement
P_{Ref} = (U_{REF}) $^2/R_{REF}$

Units for digital level measurement results:

Functions: RMS & S/N, RMS-Select, PEAK, QPEAK Input-Disp: PEAK, Input Disp: RMS

Basic unit: Full Scale FS 0 to 1

Table 2-3 Units for digital level measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
FS	FS	
%FS	PCTFS	FS×100
dBFS	DBFS	20 × log (FS)
Hex *)	HEX	FS×65535
Δ%	DPCT	$(FS/U_{REF}-1) \times 100$
dBr	DBR	$20 \times \log (FS/U_{REF})$
LSBs	LSBS	$FS \times 2^{\text{audio bits-1}}$
bits	BITS	$ld (FS \times 2^{\text{audio bits-1}} + 1)$

V_{Ref} = Reference from the ANALYZER panel of the functions RMS & S/N, RMS-SELECT, PEAK, QPEAK, DC or Input-PEAK/RMS measurement

*) Level measurement result in hex
The full-scale (FS) value measured at the digital interface as the result of a digital analyzer function is displayed as a 6-digit hexadecimal number (6 digits= 24 bit = 23 bit mantissa +1 sign bit) in the measured value window, for example:

Table 2-4 Level measurement results FS/Hex

FS value	Hex display
1.0	7FFFFF Hex
0.9	733333 Hex
0.5	400000 Hex
0.0001	000347 Hex
0.0	000000 Hex
-0.0001	FFFCB9 Hex
-0.5	C00000 Hex
-0.9	8CCCCD Hex
-1.0	800000 Hex

All digital analyzer functions provide FS values in the range from 0 to 1. Exception: the peak measurement functions PEAK & S/N and Q-PK & S/N may provide FS values < 0 or >1, depending on the PEAK mode selected. All values < -1 and >1 are displayed as 80000 Hex and 7FFFFF Hex, respectively.

FS values > 1 may occur

- with the function PEAK & S/N together with Meas Mode PK+, when applying a square signal. Being band-limited, overshoots at the edges (Gibb's phenomenon) occur, which, with peak evaluation, are included as part of the measurement result.
- with the measurement function PEAK & S/N together with Meas Mode PK to PK or PKabs.

FS values < 0 may occur

- with the function PEAK & S/N together with Meas Mode PK-.

Units for analog and digital interference level measurement results:

Functions: THD, THD+N/SINAD, MOD DIST, DIM, DFD
Basic unit: %

Table 2-5 Units for analog and digital interference level measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
%	PCT	
dB	DB	20 * log ([%] * 100)

Unit for analog and digital S/N measurement results:

Functions: RMS, PEAK, QPEAK with S/N measurement on

Table 2-6 Unit for analog and digital S/N measurement result

Value in	IEC/IEEE-bus notation	Conversion formula
dB	DB	20 * log(S/N)

S: Measured level with generator on
N: Measured level with generator off

Units for analog and digital frequency measurement results:

Basic unit: Hz

Table 2-7 Units for analog and digital frequency measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
Hz	HZ	
ΔHz	DHZ	$Hz-F_{REF}$
Δ%Hz	DPCTHZ	$100 * (Hz - F_{REF})/F_{REF}$
Toct *	TOCT	$\log (Hz/F_{REF}) * 9.96578$
Oct	OCT	$\log (Hz/F_{REF})/0.30103$
Dec	DEC	$\log (Hz/F_{REF})$
f/fr	FFR	Hz/F_{REF}

*) Toct = Third Octave

F_{Ref} = Reference parameter from ANALYZER panel of frequency measurement

Units for phase measurement results:

Basic unit: degree

Table 2-8 Units for phase measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
°	DEG	
RAD	RAD	$P[°] * (\pi/180)$
Δ°	DDEG	$P[°] - D_{REF}$
ΔRAD	DRAD	$(P[°] - D_{REF}) * (\pi/180);$

D_{Ref} = Reference parameter from ANALYZER panel of phase measurement

Units for group-delay measurement results:

Basics unit: s

Table 2-9 Units for group-delay measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
s	S	
Δs	DS	$\tau[s] - D_{REF}$

D_{REF} = Reference parameter from ANALYZER panel of phase measurement

Unit for analog and digital wow & flutter measurement results:

Basic unit: %

Table 2-10 Units for analog and digital wow & flutter measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
%	PCT	

Unit for digital jitter measurement results:

Basic unit:UI

Table 2-11 Unit for digital jitter measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
UI	UI	
%UI	PCTUI	100 × UI
dBUI	DBUI	20 × log (UI)
ppm	PPMUI	10^6 × UI
ns	NS	10^9 × UI /(128 × sample frequency)
dBr	DBR	20 × log (UI/U_{REF})

Unit for digital phase measurement results (PhaseToRef):

Basic unit: UI

Table 2-12 Unit for digital phase measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
UI	UI	
%FRM	PCTFRM	100 × UI / 128
°FRM	DEGFRM	360 × UI / 128
ns	NS	10^9 × UI /(128 × sample frequency)

Jitter and delay are usually stated in UI (unit interval). UI is defined as the smallest pulse width of the digital audio signal (eye width) and is independent of the selected sampling rate. One UI corresponds to the clock period of the digital signal (biphase clock). With digital audio signals, one UI corresponds to the 128th of the sampling period; at 48 kHz one UI is approx. 163 ns.

2.4.2 Units for the Entry of Values

To simplify the matter

- the input values are designated only by the unit in the following conversion formulas.
  Example: "dBu" actually means "value in dBu".
- the conversions into µ, m, k, M have been left out.

Table 2-13 Absolute analog level units (without reference voltage)

Conversion formulae		IEC/IEEE-bus notation
Vpp = depending on the generator function (see 2.5.4 for respective signal function)		VPP, VPP, UVPP
dBu = 20 * log (V/0.7746)	$V = 0.7746 * 10^{(dBu/20)}$	DBU
dBV = 20 * log (V)	$V = 10^{(dBV/20)}$	DBV
dBm = 10 * log (V^2 * 1000/R_{REF})	$V = \sqrt{10^{(dBm/10)} \cdot R_{REF} / 1000}$	DBM
W = V^2/R_{REF}	$V = \sqrt{(W \cdot R_{REF})}$	W, mW, uW

*) For the generator, the reference impedance is fixed to R_{REF} = 600 ohm.

Table 2-14 Relative analog level units (with reference voltage)

Conversion formulae		IEC/IEEE-bus notation
$\Delta V = V - U_{REF}$	$V = \Delta V + U_{REF}$	DV, Dm,V, DuV
$\Delta\%V = (V/U_{REF} - 1) * 100$	$V = U_{REF} * (1 + \Delta\%V/100)$	DPCTV
$V/Vr = V/U_{REF}$	$V = V/V_r * U_{REF}$	VVR
$\%V/Vr = V/U_{REF} * 100$	$V = \%V/Vr * U_{REF}/100$	PCTV/VR
$\Delta W = (V^2 - U_{REF}^2)/R_{REF}$	$V = \sqrt{(dW \cdot R_{REF}) + U_{REF}^2}$	DW
$\Delta\%W = (V^2 - U_{REF}^2) * 100/U_{REF}^2$	$V = \sqrt{U_{REF}^2 \cdot (\Delta\%W / 100 + 1)}$	DPCTW
$P/Pr = V^2/UREF^2$	$V = \sqrt{P / Pr \cdot U_{REF}^2}$	P/PR
$\%P/Pr = V^2/U_{REF}^2) * 100$	$V = \sqrt{\%P / Pr \cdot U_{REF}^2 / 100}$	PCTPPR
$dBr = 20 * \log (V/U_{REF})$	$V = 10^{(dBr/20)} * U_{REF}$	DBR
V/on= V/Burstamp[V]	V = V/on * Burstamp[V]	V/VON
%on = 100 * V/Burstamp[V]	V = %on * Burstamp[V]/100	PCTON
dBon= 20 * log (V/Burstamp[V])	$V = 10^{(dBon/20)}$ * Burstamp[V]	DBON

Table 2-15 Absolute digital level units (without reference)

Conversion formulae		IEC/IEEE-bus notation
bits = - 3.322 * log (FS)	$FS = \frac{2^{bits}-1}{2^{Audiobits}-1}$	BITs
%FS = 100 * FS	FS = %FS/100	PCTFS
dBFS = 20 * log (FS)	$FS = 10^{(dBFS/20)}$	DBFS
LSBS =FS * $2^{\text{Audio bits-1}}$	$FS = \frac{LSBS}{2^{Audiobits}-1}$	LSBS

Table 2-16 Relative digital-level units (with reference)

Conversion formulae		IEC/IEEE-bus notation
$dBr = 20 \times \log (FS/U_{REF})$	$FS = 10^{(dBr/20)} \times U_{REF}$	DBR
$\Delta\% = 100 \times (FS/U_{REF} - 1)$	$FS = (\Delta\% / 100 + 1) \times U_{REF}$	DPCT
%on = 100 × FS/Burstamp[FS]	FS = %on × Burstamp[FS]/100	PCTON
$dBon = 20 \times \log (FS/Burstamp[FS])$	$FS = 10^{(dBon/20)} \times Burstamp[FS]$	DBON

Table 2-17 Absolute time units

Conversion formula		IEC/IEEE-bus notation
s		S, MS, US
min = 60 s	s = min / 60	MIN
cyc = s * signal frequency	s = cyc / signal frequency	CYC, KCYC, MCYC

Table 2-18 Relative time units

Conversion formula		IEC/IEEE-bus notation
$\Delta s = s - T_{REF}$	$s = \Delta s + T_{REF}$	DS, DMS, DUS
min = 60 s	s = min / 60	MIN
cyc = s * signal frequency	s = cyc / signal frequency	CYC, KCYC, MCYC

Table 2-19 Absolute frequency units

Conversion formula	IEC/IEEE-bus notation
Hz	HZ KHZ

Table 2-20 Relative frequency units (with reference)

Conversion formulae		IEC/IEEE-bus notation
$\Delta Hz = Hz - F_{REF}$	$Hz = \Delta Hz + F_{REF}$	DHZ, DKHZ
$f/fr = Hz/F_{REF}$	$Hz = f/fr * F_{REF}$	FFR
$\Delta\%Hz = 100 * (Hz - F_{REF})/F_{REF}$	$Hz = \Delta\%Hz * F_{REF}/100 + F_{REF}$	DPCTHZ
$Toct^*) = lg (Hz/F_{REF}) * 9{,}96578$	$Hz = 2^{(Toct/3)} * F_{REF}$	TOCT
$Oct = lg (Hz/F_{REF}) * 3{,}32193$	$Hz = 2^{(Oct)} * F_{REF}$	OCT
$Dec = lg (Hz/F_{REF})$	$Hz = 10^{(Dec)} * F_{REF}$	DEC
*) Toct = Third Octave = Terz		

Table 2-21 Absolute phase unit

Conversion formula		IEC/IEEE-bus notation
rad = °· * (PI/180)·	° = rad * (180/PI)	RAD

Table 2-22 Relative phase unit

Conversion formula		IEC/IEEE-bus notation
$\Delta° = ° - D_{REF}$	$° = \Delta° + D_{REF}$	DDEG
Δ RAD = $(° - D_{REF}) * (\pi / 180)$·	$° = (\Delta \text{ RAD} * 180 / \pi) + D_{REF}$	DRAD

Table 2-23 Deviations (tolerance) compared to the previous measured values in the settling function (see 2.3.4 and 2.6.5.1)

Conversion formula		IEC/IEEE-bus notation
% = $(10^{dB/20} - 1) * 100$	dB = 20 * lg (%/100 -1)	DB, PCT

Table 2-24 Step size of a logarithmic level sweep

Conversion formula		IEC/IEEE-bus notation
MLT = $10^{dB/20}$	dB = 20 * log (MLT)	MLT, DB

Table 2-25 Absolute resistance unit

Conversion formula	IEC/IEEE-bus notation
Ω	OHM, KOHM

Legend:

FS:	Abbreviation for Full Scale = ratio 0 to 1
U_{REF}:	Level reference value in V or FS → *)
R_{REF}:	"Ref Imped" parameter from ANALYZER panel
F_{REF}:	Frequency reference value in Hz
Burstamp:	High level of generator burst signal, see 2.5.4.5 SINE BURST
Signal frequency:	Frequency of generator burst signal or pulse signal, see 2.5.4.5 BURST, 2.5.4.6 SINE2 BURST
D_{REF}:	Phase reference value in ×
MLT:	Multiplication factor (marked by "*" in the panel)

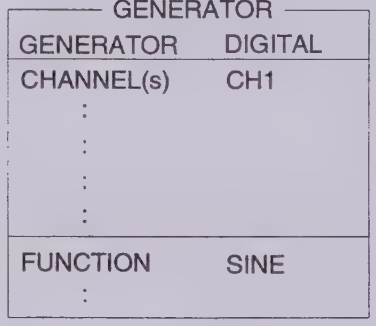
2.5 Generators (GENERATOR Panel)

Activating the GENERATOR panel:

- *UPL front panel*: GEN
- *External keyboard*: ALT + G
- *Mouse*: (repeated) clicking of the panel name, until the generator panel is displayed.

If the GENERATOR panel is already visible on the screen, it can be activated also by actuating one of the TAB keys (repeatedly) or by mouse-click.
Advantage: The panel need not be established again.

- The GENERATOR panel is always displayed on the left side of the screen and consists of two segments: configuration and function.



Select instrument (analog or digital).

Configuration segment for setting the outputs.
(output connectors, channel select, output impedance / sample frequency, etc.)
see 2.5.2 Configuration of the Analog Generator
see 2.5.3 Configuration of the Digital Generator

Functions (waveforms) of the Generator, see 2.5.4

When changing the *function* (generator signal)

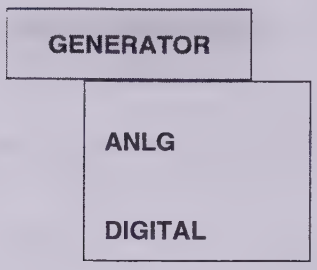
- the current function is stored to the hard disk;
- the desired function is loaded from the hard disk, initialized and, if possible, started.

When changing the *generator* (e.g. **DIGITAL** instead of **ANLG**)

- the current generator with all settings and the current function is stored to the hard disk;
- the desired generator with the currently active function is loaded from the hard disk, initialized and, if possible, started.

Note: *The "parameter link" function which can be selected in the OPTION panel may be used to influence the UPL with changes of function and instrument. As requested, existing settings in the function and/or configuration segment of the generator panel are accepted for the new function or instrument - if physically possible. A change of instrument from ANLG to DIGITAL can be performed by way of example without the function and its frequency parameters changing in the panel.*

2.5.1 Selecting the Generator



The GENERATOR panel contains the settings for the analog and the digital generators.

Two-channel analog generator 2 Hz to 21.75 kHz with low-distortion generator (UPL-B1 option) up to 110 kHz

Two-channel digital generator 2 Hz to 21.904 kHz

The standard analog generator can be supplemented by the Low-distortion Generator option (UPL-B1) for sinewave generation in the analog range, thus allowing for generating a particular low-distortion sinewave signal with a frequency of up to 110 kHz.

- Frequency range of the digital GENERATOR

The maximum generator output frequency is given by:

$$f_{max} = sample\ frequency \times 117 / 256$$

The sample frequency is set in the configuration segment of the GENERATOR panel using the menu item Sample-Frq.

There are 3 states the active generator (visible in the panel) can assume (see 2.3.5 Status Display):

- RUNNING: The set function (generator signal) is output via the specified interface.
- BUSY: Generator output signal is calculated.
- HALTED: Generator is halted, no output signal; the outputs are terminated.

RUNNING, i.e. a signal is constantly output, is the normal status of the generator. It is automatically restarted after a generator reset.

The generator can be manually restarted at all times by calling the generator or the function (open the respective selection window and confirm using ENTER). This may be required with burst signals to enable beginning of a new interval (with the burst phase).

The setting of some signals (e.g. specific noise signals) involves a lot of computations. During this time, the generator does not produce any signal and is in the BUSY state. After having successfully concluded the computations, the generator automatically re-enters the RUNNING state. If further settings are made or keys are pressed during computation, the computation is aborted and automatically restarted. The generator shortly assumes the HALTED state.

Other reasons for halting the generator (HALTED):

- Faulty setting (e.g. wrong file name for an equalization or sweep list).
  Remedy: eliminate the cause of error; restart, if required.
- On the digital instrument:
  Applying a too high external frequency (generator is "overrun").
  Remedy: reduce the external clock frequency and restart.

2.5.2 Configuration of Analog Generator

The generator can be used as balanced or unbalanced source with one or two output channels. Various internal resistors are selectable.

The complete generator is designed to be floating to frame potential.

The below overview of possible settings is followed by substitute circuit diagrams showing the three balanced and unbalanced output.

Channel(s)

The deactivated channel is internally terminated with the internal impedance set.

OFF	both channels off
1	channel 1 on, channel 2 off
2	channel 2 on, channel 1 off
2 ≡ 1	identical signal on both channels

Output

The XLR connectors can be operated either balanced (BAL) or unbalanced (UNBAL).

UNBAL	an unbalanced signal is generated at the XLR connector; the maximum output level is 10 V.
BAL	a balanced signal is generated at the XLR connector; the maximum output level is 20 V. The output impedance can be selected in 3 steps. I

Impedance

Selection of generator source impedance with Output BAL selected.

10 Ω
200 Ω (150 Ω)
600 Ω

The possibility for selecting a generator source impedance of **150 Ω** is offered when the standard generator source impedance of 200 Ω is changed to 150 Ω by means of Modification Analog Generator UPL-U3 (Order No. 1078.4900.02).

The output impedance of an unbalanced output is generally 5 Ω.

Volt Range

The selected voltage range determines the setting of the generator source impedance.

AUTO

The internal signal paths are driven at maximum level, the output voltage is set with the aid of the output amplifier.
Advantage: optimum noise and THD values for measurements with constant level, e.g. frequency sweep.

In the next menu line under "Max Volt" a maximum voltage can be entered; voltages higher than those specified here are *not permissible.*

FIX:

The output amplifier is set to the specified maximum voltage. The actual output voltage is obtained from small digital values on the D/A converter. When the output voltage changes, setting the analog hardware is not required. **Advantages**: no voltage drops on attenuator switchover. Faster level changes and better transient response for measurements with slight level variations, e.g. frequency sweep using an equalization file. (This setting should be used for loudspeaker measurements).

Enter the numeric value of the voltage range in the next menu line; voltages higher than those specified here *are not possible.*

Note: *This setting is ignored when the low-distortion generator option (UPL-B1) is used. Level control of the low-distortion generator is always performed in line with the AUTO algorithm.*

Max Volt

Limit value for the output voltage; prevents the inadvertent entry of exceeded voltage values.

The RMS value for sinewave signals is entered, i.e. the peak value of Max Volt is $\sqrt{2}$ times higher.

Ref Freq

Reference value for relative frequency units.
A change of the reference frequency causes all reference-related frequency settings to be changed.
The relative frequency of the generator signal is retained.

For instance, by varying the reference frequency the fundamental of a distortion spectrum set by means of a multisine signal may be shifted without the harmonics having to be recalculated and reset by the user.

Note: *If a generator frequency sweep is active ("X-Axis FREQ"), and AUTO scaling has been selected in the DISPLAY panel for the X axis, the reference value will be used as the Y-axis reference value in the DISPLAY panel when a new value is entered.*

Ref Volt

Reference value for the relative voltage units.
A change of the reference level causes all reference-related voltage inputs to change.
The relative voltage of the generator signal is retained.

Varying the reference voltage may, e.g., shift a level sweep defined by relative start and stop levels by a constant "gain factor".

Note: *If a generator level sweep is active (X-Axis VOLT) and AUTO scaling has been selected in the DISPLAY panel, the reference value will be used as the X-axis reference in the DISPLAY panel when a new value is entered.*

2.5.2.1 Unbalanced Output (Output UNBAL)

The unbalanced output signal is applied between pin 2 (hi) and pin 3 (lo) of the XLR connector.

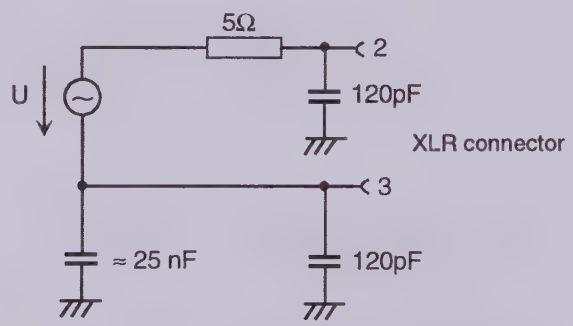
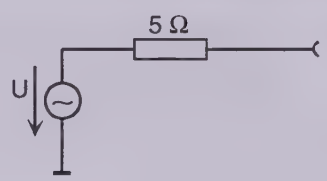


Fig. 2-12 Unbalanced output

Depending on the selected channel setting, the following output circuits are possible (capacitances are omitted):

Channel(s)
1 or 2



Channel(s)
2 ≡ 1

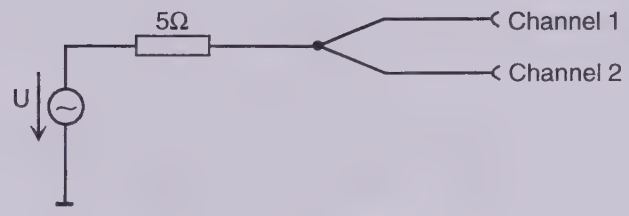


Fig. 2-13 Unbalanced output

2.5.2.2 Balanced Output (Output BAL)

The output signal is applied between contacts 2 and 3 of the XLR female connector. The source impedance is presented by two equal resistors, one in each signal line.

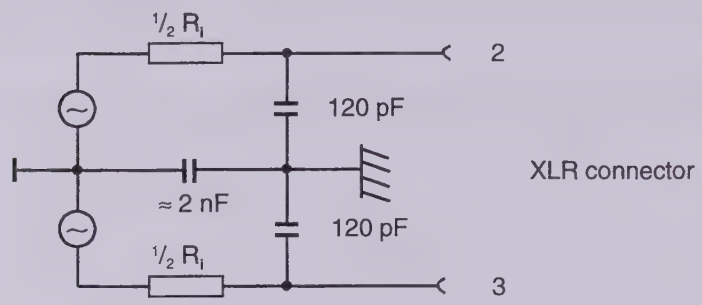
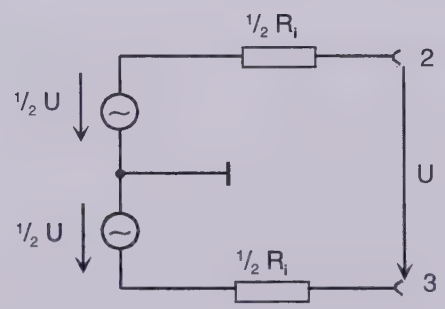


Fig. 2-14 Balanced output

Depending on channel and impedance, the following output circuits are obtained.
(Capacitances are not included in the figure):

Channel(s)
1 or 2



Channel(s)
2 ≡ 1

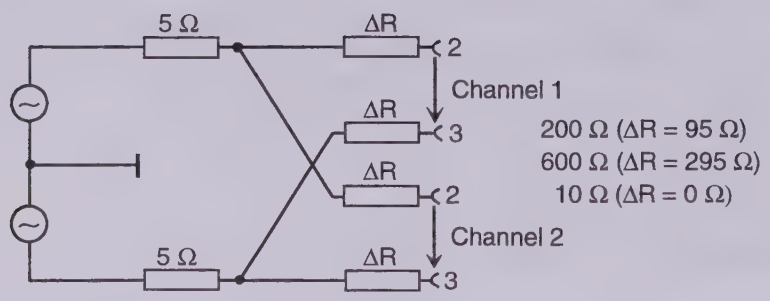


Fig 2-15 Balanced output

2.5.2.3 Output Power

The output amplifier, attenuator and all internal resistors are short-circuit proof. The peak current is limited to about 200 mA. With a maximum rms value of the output voltage of 20 V balanced and 10 V unbalanced, the maximum power loss in the load resistor (with a short-circuit in the internal resistor) is 2.8 W or 1.4 W.

Delicate devices under test might be damaged or even destroyed by an output voltage inadvertently selected too high. For this reason, the maximum settable voltage can be limited (Max Volt).

2.5.3 Configuration of the Digital Generator

Src Mode

(Source Mode); indicates what is to be generated at the digital interfaces.

AUDIO DATA

The function generator generates digital audio data. An analog jitter signal produced by the auxiliary generator (AUX GEN) or a common signal can added to the audio data stream. The audio signal is available at all digital interfaces.

JITTER

The function generator generates an analog jitter signal. All frequency and level settings refer to the jitter signal, the audio data remain constant. The audio signal is available at all digital interfaces.

PHASE

Like AUDIO DATA, the frame phase of the audio data stream to the REF output (rear of instrument) can be set. The user-defined phase depends on the following conditions

Sync To: GEN CLK only
Sync Out: ***not*** SYNC PLL
Ref Out: REF GEN only
Jitter Ref: GEN CLK only (ANALYZER panel

Note: *Although an audio signal can also be generated under this menu, PHASE should only be selected if the definable phase reference is required.*

COMMON ONLY

A balanced analog signal is superimposed onto the audio data stream on the two lines of the XLR connector. All frequency and level settings refer to the analog common signal, the audio data remain constant. The common-mode signal is available at the BAL digital interfaces only.

PhaseToRef

Displayed only, if PHASE has been selected as source mode.
Setting of the frame phase between the digital audio output and the REF output (rear).
Specified range: -64 UI to +64 UI (corresponds to -180º to +180º).
Units: UI | %FRM | ºFRM | ns

Unbal Out

indicates what is applied to the UNBAL (BNC) output.

AUDIO OUT

The *generated* AUDIO data are present (also at BAL (XLR) and optical output).

AUDIO IN

The digital AUDIO data received (at the UNBAL or BAL input) are present (front panel), e.g., an oscilloscope for examining the input signal may be connected here.

Cable Sim

(Cable Simulation)

A cable length of approx. 100 m can be simulated at the UNBAL (BNC) or BAL (XLR) outputs.

OFF	Cable simulation switched off.
LONG CABLE	Cable simulation switched on for both electrical outputs (BAL and UNBAL).

Note: *Cable simulation is effective even if the AUDIO IN signal is applied to the UNBAL (BNC) output.*

Sync To

(Generator synchronized to)

indicates what the digital audio generator is synchronized to. Depending on the "Src Mode", certain selections cannot be made.

AUDIO IN	Synchronization to the audio input signal; *not* possible with JITTER ONLY or PHASE.
REF IN	Synchronization to the REF IN input signal (XLR socket on the rear panel); *not* possible with PHASE.
SYNC IN	Synchronization to the SYNC IN input signal (BNC connector on the rear panel) *not* possible with JITTER ONLY or PHASE.
GEN CLK	Synchronization to the internal clock generator

Sync Mode

is displayed only if the generator is synchronized to the SYNC IN input (rear); indicates the synchronization mode used.

VIDEO 50	Sample frequency synchronized to a video frequency of 50 Hz. (Europe).
VIDEO 60	Sample frequency synchronized to a video frequency of 60 Hz (USA).
	Note: *with VIDEO 50 and VIDEO 60, an appropriate composite video signal must be applied to the SYNC input*
1024 kHz	Sample frequency synchronized to a 1024-kHz reference signal.
WORD CLK	Sample frequency synchronized to the word-clock signal at the SYNC input.
WRD CLK INV	Sample frequency synchronized to the inverted word-clock signal at the SYNC input.

Sample Frq

Setting the output clock rate.

Depending on the selected synchronization in the generator-menu line "Sync To" the following information on the clock rates can be given:

32 kHz
44.1 kHz
48 kHz

The 3 fixed frequencies can be selected when the generator is internally clocked or synchronized via the SYNC IN female connector. This is specified in the menu line

"Sync To" GEN CLK or SYNC IN

VALUE

The generator must be clocked internally in order to enable a user-definable value to be entered under "VALUE":

"Sync To" GEN CLK

EXTERN

An external clock can be entered as a numeric value when the generator is synchronized to a word-clock signal (inverted, if required) via the SYNC IN or via the REF IN female connector:

"Sync To" SYNC IN
"Sync Mode" WORD CLK or WORD CLK INV

Important: *If the frequency entered does not correspond to the frequency applied, the frequencies of the generated signals vary correspondingly! The applied sample frequency must be in the range between* ***27 kHz and 55 kHz;*** *if these limits are exceeded the synchronization may be lost and the processor of the generator may be overloaded*

Status display: GEN: ORUN;

Remedy: *Reduce the external clock rate and restart the generator by acknowledging the generator instrument.*

SYNC TO ANL

If the generator is synchronized to the input signal of the analyzer, this selection item is displayed; it cannot be modified. The synchronization to the analyzer is defined in menu line

"Sync To" AUDIO IN

The numeric value of the sample frequency is copied from the analyzer panel and cannot be modified in the generator panel.

Note *The selected sample frequency can be copied automatically into the Channel -Status Bits. The Channel status file or the "Panelfile" used here has to contain appropriate keywords (see 2.5.3.2 AES/EBU protocol definition). The example files with the extensions *PGC and *PPC are already configurated. Using the panel file the user can choose in the protocol menu of the generator panel whether the automatism should be applied ("Rate GEN SMPLFRQ") or whether a fixed sample rate should be entered into the Channel Status Bits.*

Sync Out

specifies the clock signal applied to the SYNC OUT output (BNC female connector on the rear of the instrument).

AUDIO IN	Digital AUDIO input signal (front panel)
REF IN	REF IN input signal (XLR female connector on the rear panel);
SYNC PLL	signal from the internal synchronization PLL (e.g., input signal with eliminated jitter)
GEN CLK	internal generator clock

Type

indicates the type of SYNC OUT signal

WORD CLK	word-clock signal (sample frequency)
BIPHASE CLK	biphase clock signal (128 times the sample frequency)

Ref Out

specifies the signal applied to the REF OUT output (XLR female connector on the rear).

AUDIO IN	(buffered) audio input signal;
AUD IN RCLK	audio input signal reclocked by the internal synchronization PLL
AUDIO OUT	generated audio signal (same as on the front panel)
REF GEN	generated reference signal, which can be defined constant low (ALL ZERO) or constant high (ALL ONE) in the next menu line "Data".

Data

is displayed only, if REF GEN has been selected for REF OUT signal.

Defines the audio data which are output at the REF OUT output (XLR female on the rear panel).

ALL ZERO	all data bits are *re*set (low level)
ALL ONE	all data bits are set (high level)

Audio Bits

Displayed only when Src Mode AUDIO DATA is selected. Word width of generated audio samples in bits.

Value range: 8 to 24

If the word width is reduced, the values of the audio samples are rounded to the specified word width.

Unbal Vpp

Sets the output voltage of the digital signal at the UNBAL (BNC) interface.
Peak-to-peak voltage upon termination with nominal impedance (75 Ω); without termination the voltage is twice as high.

Setting range: 0 mV to 2.125 V; resolution 8.33 mV

This voltage is always ¼ of the voltage at the BAL (XLR) interface.

Bal Vpp

Sets the output voltage of the digital signal at the BAL (XLR) interface.
Peak-to-peak voltage upon termination with nominal impedance (110 Ω); without termination the voltage is twice as high.

Setting range: 0 mV to 8.5 V

This voltage is always 4 times as high as the voltage at the UNBAL (BNC) interface.

Max Volt

Displayed only if Src Mode AUDIO DATA or phase has been selected. Limit value for entry of the output; prevents inadvertent entry of impermissibly high voltage values .

Ref Freq

Reference value for the relative frequency units.
A change of the reference frequency causes all reference-related frequency inputs to change.
The relative frequency of the generator signal is retained.

By varying the reference frequency, the fundamental of a distortion spectrum set by means of multisine can for example be shifted without the harmonics having to be recalculated and set again by the user.

Note: *If a generator frequency sweep is active (X-Axis FREQ) and AUTO scaling is selected for the X axis in the DISPLAY panel, the reference value is used in the DISPLAY panel as the X-axis reference when a (new) value is entered.*

Ref Volt

Reference value for the relative voltage units.
A change of the reference level causes all reference-related voltage inputs to change. The relative voltage of the generator is retained.

By varying the reference voltage, a level sweep defined with relative start and stop levels can for example be shifted by a constant gain factor.

Units (depending on source mode):

AUDIO DATA/PHASE: FS | %FS | dBFS | Δ% | LSBs | dBr | bits

JITTER ONLY : UI | %UI | dBUI | ppm | ns | UIr | dBr

COMMON ONLY: V | mV | µV | dBV | dBu

Note: *If the reference value is entered with a reference-related unit (e.g. dBr), the entered value is converted to the basic unit in relation to the previous reference value and then stored. This new reference value is displayed in relation to the* ***new*** *reference value (e.g. 0 dBr). Thus any reference value can be varied by a desired factor or dB value.*

Example: *0.174 FS - 10 dBr = 0.055 FS*

Note: *If a generator frequency sweep is active (X-Axis FREQ) and AUTO scaling is selected for the X axis in the DISPLAY panel, the reference value is used in the DISPLAY panel as the X-axis reference when a (new) value is entered.*

2.5.3.1 Generating Jitter, Phase and Common Mode

With digital audio interfaces, there are two types of signals to be measured, e.g. within a quality check. One is the digitally coded analog signal, and the other the digital signal. The latter too has analog parameters such as peak-to-peak voltage, frequency etc. It may be subject to interference like an analog signal. Noise or AC voltage may be superimposed, which may cause the signal slopes to be shifted. This effect is called jitter and, if it is strong enough, the audio signal can no longer be decoded or regenerated correctly. An exactly defined interference signal is to be generated by the UPL generator to examine the compatibility to jitter.

The signal lines can be designed as balanced lines which is quite usual in analog technology. Thus, injected interference, e.g. from grounded (hum) loops, would be ineffective. However, in practice this attenuation is not always sufficient so that a common-mode voltage of sufficiently high magnitude may prevent decoding and regeneration. The UPL can generate a common-mode voltage on the digital signal in order to test instruments. Of course, a common-mode signal cannot be generated at the unbalanced and the optical output.

The UPL can thus generate and simulate two different interferences of the digital audio signals: specific shifting of the signal slopes (JITTER ONLY) and the superimposition of the digital lines (COMMON ONLY) by a common-mode voltage. The sine and noise functions (arbitrary and random) are particularly suited for practical applications.

For many applications, it would be useful to determine the audio content of the signal in addition to the jitter or common-mode signal, i.e. to generate an audio signal impaired by jitter or a common-mode voltage. Thus the influence of the disturbing signal on the audio signal can be measured with option UPL-B1 fitted. UPL offers an operating mode for this case too. An additional sinewave generator (AUX GEN) can be switched on in the source modes AUDIO DATA and PHASE where any digital audio signal can be generated to superimpose either a jitter or a common-mode signal on the audio signal.

Jitter and delay are usually stated in UI (unit interval). UI is defined as the smallest pulse width of the digital audio signal (eye width) and is independent of the selected sampling rate. One UI corresponds to the clock period of the digital signal (biphase clock). With digital audio signals, one UI corresponds to 128th of the sampling period; at 48 kHz one UI is approx. 163 ns.

If several, digitally-coded signals have to be combined, as is commonly done in the studio, the signal synchronization is also of importance. Associated frames containing the instantaneous values (samples) of the left and right channels must not be delayed to such an extent that the timing tolerances of the receiver are exceeded. The UPL can simulate this error by rendering the phase between the digital output on the front panel and the independent reference generator with output on the rear panel adjustable. This refers to the phase within a frame (or 64 bits or 128 UI).

Even if the clock frequency is precisely generated by the various instruments, the frequencies tend to drift with respect to one another, which can be noticed as a phase offset (see above). This drift causes omission or doubling of individual samples. This effect can be avoided by distributing a frame sync or word clock to all instruments for synchronization, or by synchronizing them to a common clock frequency (e.g. 1024 kHz or the video sync pulses). Hence, if the UPL is to behave like an ideal source of digital signals, it must be integrated into this synchronization concept. It can, therefore, be synchronized via the SYNC IN female on the rear panel to the signals selected by means of the Sync Mode command.

In addition to the method described above, the generator can also be synchronized to the digital signal at the analyzer input using a clock frequency. A differentiation has to be made between the input on the front panel and the input of the reference receiver on the rear panel. Moreover, the generator can be operated with an own crystal oscillator.

The mode set (phase, jitter or common mode), i.e. the superimposed interference voltage always refers to the digital output on the front panel. The reference generator whose output is on the rear panel is always used as reference. If the generator is operated with external synchronization, ('Sync To' does not select GEN CLK), the reference corresponds to the synchronization. Besides, the synchronization output ('Sync Out' on the rear panel) is always without jitter or phase shift.

2.5.3.2 AES/EBU Protocol Definition

Selection of the digital generator causes the additional section PROTOCOL to be displayed in the GENERATOR panel. This section sums up the commands for definition of the protocol information (channel status data, user data, validity, parity).

PROTOCOL

Determines the volume of the generated protocol information.

PANEL OFF

No entry of channel status data. The last-defined state is permanently retained.
If the generated channel status data are irrelevant, the undesired menu lines can be deleted from the GENERATOR panel.

STATIC

Only rudimentary channel status data - RAW data to be defined for both channels via a file - can be generated. This mode is always possible without any restrictions.

ENHANCED

Selectable only when option UPL-B21 (digital audio protocol) is installed.
The full range for protocol data generation can be entered and is displayed in the GENERATOR panel. CRC and Local Time Code can be generated, with generator start the local time code is reset and automatically counted up.
In this mode also the analyzer has to be set to protocol analysis. Consequently the following settings are made automatically in the ANALYZER panel when ENHANCED is switched on:

- INSTRUMENT DIGITAL
- Anlr Mode AUDIO DATA
- FUNCTION PROTOCOL

The other way round, the ENHANCED mode is switched off as soon as one of the three mentioned analyzer menu lines is changed.

Validity

Set the validity identification within the AES/EBU data stream.

NONE

No validity bit set

1&2

Validity bit set in both channels

Ch Stat. L

Define how the channel status data LEFT are generated.

ZERO

All channel status data bits are 0. (The operating mode (AES3, CRC, RAW) is defined with the command Ch Stat. R).

FILE + AES3

UPL generates local timecode and CRC, other channel status data are defined using the following file.

PANEL + AES3

UPL generates local timecode and CRC, other channel data are set using the panel defined by the "Panelfile" file.

FILE + CRC
PANEL + CRC

As FILE + AES3 or PANEL + AES3, however UPL does not generate local timecode, which is a fixed setting instead.

FILE

As FILE + AES3 or PANEL + AES3, however UPL generates neither local timecode nor CRC (RAW mode).

PANEL

The setting that can be made under this menu item affects Ch Stat. R. Any settings under Ch Stat. R. that are incompatible with the selection made here causes a corresponding error message to be output and the setting to be rejected.

The following restrictions apply:

- PANEL (= user-definable generator commands) can only be used with Ch Stat L or Ch Stat R.
- The operating mode must be the same for both channels.

BINARY...

If this parameter is selected, a menu is displayed which allows for binary entry of the individual channel-status bits. The data are copied in by actuating the OK field. BIN ENTRY can be used once with CH Stat L or Ch Stat R, only. The SELECT key (or space bar on the external keyboard) causes the respective bit to change from 0 to 1 or vice versa.

Note: *Local Time Code is a counter defined in accordance with AES3 which indicates the time elapsed since the beginning of transmission in samples. This counter is incremented by the UPL in the PANEL+AES and/or FILE+AES modes by 192 per frame. The value indicated in the file or panel is used as start value.*

Filename

Specifies a file containing the channel status data for LEFT.

Preset file type: *.pgc

Data are defined in single lines. Keywords in the file specify for which bits and side (left, right or both) the data are intended.
With this command only the definitions containing information data for the left or for both sides are considered. Thus the same file can be used for both sides.

Syntax:

Side: AES_CHAN_STAT or AES_CHAN_STAT_BOTH indicate the beginning of data for both sides. Analogously, AES_CHAN_STAT_RIGHT and AES_CHAN_STAT_LEFT indicate the beginning of data for one side.

These keywords may be used in any order and as often as desired.

Data: Values in the file are entered with the following line:

Keyword BIT followed by a destination range and the respective value.

Example: BIT:12-15, 1

(bits 12-15 are assigned 0001)

The ***time*** of the UPL can be specified using the keyword TIME instead of a value. To obtain the number of samples made since midnight, the time is multiplied by the currently selected sample rate (see section 2.5.3).

Example: BIT:112-143, *TIME*

The ***sample rate*** selected in the configuration section of the UPL generator (see section 0) can be entered automatically into the specified bit position using keyword RATE_TRK. UPL. UPL recognizes by means of the bit position whether the sample rate has to be coded in the consumer or the professional format and enters the respective values accordingly.

Example: BIT:6-7, *RATE_TRK* (professional format)

BIT:24-27, *RATE_TRK* (consumer format)

Example file: R&S_AES3.PGC (Professional format)

Notes: *The local time (bit #112 to #143) is set to 0 when the generator is started and upcounted with the sample rate, i.e. it indicates the number of samples made since the generator start. In protocol analysis the time elapsed since the start of the generator can be determined by considering the sample rate.*

The absolute time (bit #144 to #175)) with the number of samples made since midnight is loaded when the generator is started and remains unchanged. In protocol analysis the time of the generator start can be determined by considering the sample rate.

Thus the actual time can be determined at any time by adding Local and Time.

Ch Stat. R

Specify how to generate the Channel Status data RIGHT.

The setting that can be made here is a function of Ch. Stat. L. The PANEL can be assigned only once. The operating mode (AES3, CRC, RAW) must be the same for both channels.
For more details on the individual commands, refer to Ch. Stat L.

ZERO	All channel status data bits are 0. (Operating Mode (AES3, CRC, RAW) is defined by Ch. Stat L. When Left is also set to ZERO, the operating mode is RAW).
EQUAL L	Both sides are the same. All definitions made for the left side are copied to the right. The operating mode is defined by Ch. Stat L.
FILE+AES3	This selection is displayed only when ZERO, FILE+AES3 or PANEL+AES3 have been selected for Ch. Stat L.
PANEL+AES 3	This selection is displayed only when ZERO, FILE+AES3 have been selected for Ch. Stat L.
FILE+CRC	This selection is displayed only when ZERO, FILE+CRC or PANEL+CRC have been selected for Ch. Stat L.
PANEL+CRC	This selection is displayed only when ZERO or FILE+CRC have been selected for Ch. Stat L.
FILE	This selection is displayed only when ZERO, PANEL or FILE have been selected for Ch. Stat L.
PANEL	This selection is displayed only when ZERO or FILE have been selected for Ch. Stat L.
BIN ENTRY	This selection is displayed only, if BIN ENTRY has not yet been selected with Ch. Stat L.

Filename

Specify a file containing Channel Status data for RIGHT.

preset type of file: *.pgc

The data are each defined in a line. Keywords in the file specify for which bits and side (left, right or both) the data are defined (see also specifications for the left side).
When using this command, only those definitions containing data for the right or for both sides are considered. This allows you to use the same file for both sides.

Format: see Ch. Stat. L

User Mode

Specify how to generate the user data.

ZERO

All user bits are initialized to be 0.

FILE DEF

User bits are output according to the definitions in the subsequent file.

Note: *Changing the user bits stops both the generator and the analyzer for a short time.*

Filename

Specify a file containing user data.

Preset type of file: *.pgu

The file contains both user data for the left and the right side. The keyword AES–USER–DATA–LEFT is used to indicate the beginning of data for the left side. Analogously, AES–USER–DATA–RIGHT is used for the right side.

In the following lines, values must be entered as hexadecimal numbers without any further designations . Each line contains 32 bits.
The UPL repeats block-synchronously user bits read in, the length of each cycle being equal for both sides. 192 user bits can be read in on each side. Reading in less bits on one side than on the other causes zeros to be inserted. 6 (or a multiple thereof) result in correlated user data from the beginning of the block.
The maximum permissible number of user bits is 4096 words = 16384 bytes = 131072 bits per side.
Example: AES_USER_DATA_RIGHT
0x55504E20 # = 'UPL '

Panelfile

Specify a file which contains the definitions of the freely programmable panel. This menu item is displayed only when a panel has been specified for Ch. Stat L or Ch. Stat R.

Preset type of file: *.PPC

This file allows you to define an input field tailored to meet the current requirements. This file, thus, defines the screen display for entry of the actual values. To this end, enter the respective command designations, the permissible range of values and the destination of the setting into the file. Sample files for the "professional" and "consumer" format according to IEC 958 are contained in the "C:\UPL\USER" file supplied with the instrument (R&S_AES3.PPC and R&S_CONS.PPC). 4 types of commands are permissible:

- **Selection commands**

  Entering the keyword SELECTION or EXTSELECT followed by parameters defines a selection command.
  When the keyword RATE_TRK is entered with parameters specifying the sample rate, a special selection command is defined which causes item GEN SMPLFRQ to be additionally displayed in the panel. RATE_TRK may only be used where the bits for the sample rate are defined (in the consumer or professional format); otherwise this keyword has the same effect as SELECTION.

  ***Examples*:**

  ⇒ SELECTION " Use", BIT:0, 0="CONS", 1="PROF"
  (Bit 0 of the channel status data can be switched between CONS and PROF using the menu line 'Use'.)

  ⇒ SELECTION " Usermod", BIT:12-15, 0="not ind", 3="USER"
  (The four bits 12 to 15 can be switched between not ind and USER using the menu line 'Usermod'.)

  ⇒ RATE_TRK " Rate", BIT:6-7,
  0="not ind", 1="44.1 kHz", 2="48 kHz", 3="32 kHz "
  Bits 6 and 7 of the channel status data can be switched between "ANLR TRACK", "not ind", "44.1 kHz", "48 kHz", "32 kHz" and "GEN SMPLFRQ" using the menu line "Rate". By selecting GEN SMPLFRQ the sample rate selected in the generator configuration section is automatically transferred to the channel status data.

  ***Notes*:**

  ⇒ Max. 12 normal selection commands and 3 extended ones are permissible.
  ⇒ The BIT interval must not be larger than 32.
  ⇒ Max. 8 selections per command (SELECTION) are permissible. Any value within the specified range of bits can be assigned to the selections.
  ⇒ In the case of overlapping bit ranges, the most recent setting overwrites the bits defined before.
  Up to 24 selection possibilities are permissible with EXTSELECT.

- **Text commands**

  Entering the keyword TEXT followed by parameters defines a text command.

  Example:
  ⇒ TEXT " Origin", BIT:48-79
  (The 32 bits 48 to 79 of the channel status data are filled with the text characters to be entered here.)

  Note:
  ⇒ Up to 4 selection commands are permissible.
  ⇒ The BIT interval must not be larger than 32, i.e. max. 4 text characters (ASCII) per command are permissible.

- **Value commands (normal)**

  Entering the keyword VALUE followed by parameters defines a value command, which allows the specification of status bits as numbers. These numbers can even be multiplied by a multiplier specified in the file.

  Example:

  ⇒ VALUE " Abs.Hour", BIT:144-175, MULT:SET–RATE

  ⇒ MULT:3600
  (The value defined here is entered into the 32 bits 144 to 175, the number after MULT (3600 * and SET– RATE = set sample rate) being multiplied by the value before it is entered.)

  Note:
  ⇒ Max. 12 value commands are permissible.
  ⇒ The BIT interval must not be larger than 32, the entry is limited to 31 bits.
  ⇒ The two keywords MULT are optional. The keyword SET–RATE can also be used as multiplier.

- **Value commands (additive)**

  The entry of the keyword ADDVALUE followed by parameters defines a value command, the value being added to already available values.

  Example:
  ⇒ADDVALUE " Abs.Min", BIT:144-175, MULT:2880000
  ⇒(The value entered here is added to the 32 bits 144 to 175 of the channel status data. Prior to the addition, the number after MULT (2880000 = 60 * 48000) is multiplied by the value.)

  Note: See under value command (normal).

Examples:
R&S–AES3.PPC for panel acc. to AES3 format
R&S–CONS.PPC for panel acc. to consumer format

In the panel, the UPL displays the commands in the order
1. SELECTION/EXTSELECT/RATE_TRK
2. VALUE / ADD VALUE
3. TEXT

In the file, any desired order is permissible.

2.5.4 Functions

Function	
SINE	Single sine, dither may be included
MULTISINE	up to 17 sines
SINE BURST	Sine burst signal
SINE^2 BURST	Asymmetrical sine burst
MOD DIST	Test signal for intermodulation distortions
DFD	Test signal for difference frequency distortions
RANDOM	Random noise
ARBITRARY	Arbitrary waveform
POLARITY	Test signal for polarity measurements
FSK	Frequency shift keying, only with UPL-B33 installed; only required for ITU-T O33 (via automatic sequence controller).

2.5.4.1 Common Parameters for Generator Signals

2.5.4.1.1 Common Parameters for SINE, DFD, MOD DIST Signals

Frq Offset

Frequency offsets when entering frequencies.

+1000 ppm

Set the frequency with an offset of +0.1%

*Note: If the generator frequency is referenced to per GENTRACK with frequency offset switched on, the **set** frequency and not the actually generated one is used as reference (see **2.6.5.1**, RefGen)*

OFF

Set the frequency without offset

Dither

For the digital generator, only (DIG 48 kHz).

ON

A noise component is superimposed on the signals. The amplitude of the noise component can be entered in the next menu line. The power density function (PDF) can be entered further down.

OFF

No superimposed noise

PDF

Only for the digital generator (DIG 48 kHz), with activated dither
Select the amplitude distribution (probability distribution function) of the superimposed noise signal.

GAUSS

Gaussian distribution

TRIANGLE

Triangular distribution from -peak to +peak

RECTANGLE

Equivalent distribution from -peak to +peak

2.5.4.1.2 Common Parameters for All Generator Functions

DC Offset

permits the superposition of a settable direct voltage on the generator output

ON

The signals are superimposed a DC voltage content. The amplitude of the DC voltage content can be entered in the next menu line.
This selection is permitted for all functions of the function generator, except for the (analog) low-distortion generator.

OFF

no DC voltage signal active

Note: *for the analog generators, offset is limited on ± 5 V (UNBAL) or ± 10 V (BAL)*

2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM Signals

Equalizer

Activate/Deactivate an equalizer table including frequency specifications and appertaining voltage amplification factors. Depending on the frequency, the set voltage can be multiplied by an equalizing factor (after interpolation between the adjacent frequency points) before they are switched to the outputs. The equalized voltage can be measured internally by means of the analyzer.

Note: *When entering equalizing factors > 1 it may occur that the equalized voltage exceeds the selected maximum voltage (entry under menu item Max Volt) or the physically feasible voltage. If this is the case, the voltage output is limited (to the smaller of the two values).*

Typical application:
Simulating the effects of a preemphasis; measurement with constant power on DUTs with frequency response.

ON

Equalizer is switched on. Menu item "Equal. file" is activated, i.e. the file listed under this menu item is loaded.

Note: *If the generator voltage is referenced to per GENTRACK with the equalizer switched on, the **set** voltage and not the equalized one is used as reference (cf. 2.6.5.1 Reference).*

OFF

Output voltage is not affected.

Equal. file

(Equalizer file)
with Equalizer → ON only;
Menu item for entry of the equalizer file name. The file is opened and saved in an internal buffer.

Entering an invalid name (disk drive not ready, file not found, invalid format, etc.) leads to the output of an error message and the entry "not found" in the menu line.

For entering a file name, see 2.3.2.5;
For generation of an equalizer file, see 2.9.1.2 Loading and Storing of Series of Measured Values and Block/List Data ("Store → EQUALIZATN").

2.5.4.2 Sweeps

With many generator functions, it is useful to output signal parameters (level, frequency, in the case of burst signals also switch-on time and length of intervals) not only statically but to vary them with respect to time. A sweep system allowing 2 parameters to be varied simultaneously (two-dimensional sweep) is available for these signals.

- One-dimensional sweep: the parameter specified under X-axis is varied from start to stop or according to the LIST file.
- Two-dimensional sweep: the parameter specified under Z-axis is set to the start value or the first entry in the 1st LIST file. The parameter defined under X-axis is varied from start to stop or in accordance with the 2nd LIST file. The Z-parameter is then set to the next value and the sweep of the X-parameter starts again from the beginning. The two-dimensional sweep is concluded when the Z-parameter has assumed its final value. When a Z sweep is switched on, Scan count is set according to the number of Z points.

The so-called "LIST buffers", with a length of 1024 entries each, serve as data source for the sweep parameters. The total length of the LIST buffers is obtained by multiplying the lengths of X- and Z-buffer; with one-dimensional sweeps, the length of the Z-buffer is to be defined as 1. If you specify too many items, the last ones, i.e. those exceeding 1024 are ignored. Each buffer contains a table, which can either be derived from user specifications (normal sweep) or is loaded from a file (list sweep; see Sweep→Ctrl).

With normal sweeps, tables with equidistant rising or falling values are generated depending on whether the start value is lower or higher than the stop value. As soon as a "normal" sweep is switched on or a new start value is selected, the start value is set in the instrument hardware, in order to keep the settling time with starting of sweep as short as possible.

With "list-controlled sweeps", the values for the sweep parameters can be spaced as desired, however, they must be consecutive (just as with "normal" sweep) (2.9.3 Series of Measured Values (Sweeps and Scans) and Block/List Data).

If a running sweep is stopped or switched off, the swept parameters retain the current numeric values.

Note: *Sweeping from high to low frequencies allows the beginning of the sweep curve to be displayed faster than its end because high frequencies require less measuring time.*

For starting and stopping the sweep, see 2.11.

Table 2-26 List of sweepable function parameters depending on the function selected:

Function	VOLTAGE	FREQUENCY	ON-TIME	INTERVAL
SINE	yes	yes	---	---
MULTISINE	no	no	---	---
SINE BURST	yes	yes	yes	yes
$SINE^2$ BURST	yes	yes	yes	yes
MOD DIST	yes (total Volt)	yes (user frequency)	---	---
DFD	yes (total Volt)	yes (mean frequency)	---	---
RANDOM	no	---	---	---
RANDOM+ANLR	no	---	---	---
ARBITRARY	no	---	---	---
FSK	no	no	---	---
POLARITY	no	---	---	---

Remark:

In addition to the above generator sweeps, several analyzer sweeps can be performed:

- time-controlled analyzer sweeps are selected under menu item START COND in the ANALYZER panel (for all measurement functions)
- external frequency or level sweeps are also selected in the ANALYZER panel under menu item START COND (for all measurement functions)
- the bandpass mean frequency can be swept in the RMS SELECTIV measurement.

Only one generator or one analyzer sweep can be active at a time. If a 2nd sweep is selected, the first sweep is switched off again and a warning is read out.

SWEEP Ctrl

Activate/Deactivate the sweep system and specify the data source and sweep run.

OFF

The sweep system is switched off; all parameters are entered directly into the panel by the user.

AUTO SWEEP

The sweep runs automatically after having pressed the START or SINGLE key (see 2.11 Starting and Stopping of Measurements or Sweeps).
The data of the sweep parameters are obtained from user specifications (start/stop value and step size or number of points); normal sweep
Sweep stepping can be synchronized with the analyzer in menu item Next Step.

AUTO LIST

The sweep runs automatically after having pressed the START or SINGLE key (see 2.11 Starting and Stopping of Measurements or Sweeps).
The data of the sweep parameters are read from file; (list sweep) for generation of lists, see 2.9.1.2, menu item STORE TRACE/LIST, Store → X AXIS, Store → Z AXIS
Sweep stepping can be synchronized with the analyzer in menu item Next Step.

MANU SWEEP

The sweep is controlled by means of the rotary knob and/or the cursor keys. When you press the START key, the 1st measured value only is recorded. Any further sweep point must be explicitly requested using the rotary knob or by pressing a cursor key (see 2.11 Starting and Stopping of Measurements or Sweeps.
The data of the sweep parameters are obtained from user specifications (start/stop values and step size or number of points); normal sweep.
When sequencing the manual sweep, the result of the current measurement is not waited for, i.e. the current measurement and possibly a set analyzer delay are aborted.

MANU LIST

The sweep is controlled by means of the rotary knob and/or the cursor keys. When you press the START key, the 1st measured value only is recorded. Any further sweep point must be explicitly requested using the rotary knob or by pressing a cursor key (see 2.11 Starting and Stopping of Measurements or Sweeps).
The data of the sweep parameters are read from a file; list sweep.
For generation of lists, refer to 2.9.1.2, menu item STORE TRACE/LIST, Store → X AXIS, Store → Z AXIS
When sequencing the manual list sweep, the result of the current measurement is not waited for, i.e. the current measurement and possibly a set analyzer delay are aborted.

Notes on manual sweep:

- *In order to control manual sweeps using the rotary knob or the cursor keys, the graphics must be active (full-screen or part-screen mode). When the sweep is started, the switchover to the graphics panel occurs automatically.*
- *The feature "manual sweep" can be used to vary generator parameters with a user-definable increment. The increment is defined by a fixed "step" (with MANU SWEEP) or by a variable step size defined per file (with MANU LIST). In remote control mode, the command "INIT:NEXT<n>" is used to continue.*

- *Individual sweep points can be skipped by turning the rotary knob fast. Also, sweep points can be repeated by turning the rotary knob back.*
- *The measured values are represented by means of crosses in the Curve Plot mode. With the DISPLAY panel setting Scan count >1 selected, these crosses are not deleted before being updated but remain on the screen. With strongly fluctuating measurement values, the representation approximates the shape of a bar. If sweep steps are skipped or advanced too fast, a NAN (Not A Number) value is entered. When reaching the end of sweep, the complete trace (with the latest measured values) is obtained.*

Next step

With automatic sweep stepping ("Sweep Ctrl → AUTO SWEEP" or "Sweep Ctrl → AUTO LIST") only.
Select the sweep synchronization.

ANLR SYNC

Analyzer synchronization:
The sweep continues after a valid measured value has been obtained; recommended in generator/analyzer mode.

DWELL VALUE

Time synchronization with fixed time:
The sweep continues after a specified time has elapsed. The time is defined in menu item "Dwell". Required for sweeps with external analyzer.

DWELL FILE

Time synchronization using times specified in a list:
The sweep continues after specified times which are read out of a list and interpolated on the basis of the existing X-axis.
Required for sweeps with external analyzer, if the measuring or settling time of the analyzer and/or the DUT depends on the respective sweep point.

Dwell File

With automatic sweep ("Sweep Ctrl → AUTO LIST") and list-controlled time synchronization ("Next step → DWELL FILE") only.
Specify a file containing the dwell times

The file is opened and loaded into an internal buffer.

If the name entered is not valid (drive not ready, file not found, invalid format, etc.), an error message is output and the reason for the fault is entered into the menu line.
For entry of file names, see 2.3.2.5; for generation of the list, see 2.9.1.2 Loading and Storing of Traces and Lists.

Dwell

Only with automatic sweep and list-controlled time synchronization ("Next step → Dwell:value").

Enter a dwell time for all sweep points.

Specified range:	0 to 1000 s.
Units:	s | ms | µs | min
Resolution:	1 ms

X Axis

With an active sweep system only.
Select the sweep parameter (one-dimensional sweep) or the 1st sweep parameter (two-dimensional sweep).

VOLT

Signal voltage (SINE, SINE BURST, SINE^2 BURST) or total voltage (MOD DIST, DFD) is swept.

FREQ

Signal frequency (SINE, SINE BURST, SINE^2 BURST), useful frequency (MOD DIST) or center frequency (DFD) is swept.

ON TIME

Time of high level with burst signals is swept.

INTERVAL

Interval time with burst signals is swept.

Z Axis

With active sweep system, only
Select the 2nd sweep parameter for a two-dimensional sweep.

OFF

Sweep is one-dimensional

VOLT

Sweep is two-dimensional, the 2nd. sweep parameter is the signal voltage (SINE, SINE BURST, SINE^2 BURST) or total voltage (MOD DIST, DFD).

FREQ

Sweep is two-dimensional, the 2nd sweep parameter is the signal frequency (SINE, SINE BURST, SINE^2 BURST, SQUARE), wanted frequency (MOD DIST) or center frequency (DFD).

ON TIME

Sweep is two-dimensional, the 2nd sweep-parameter is the time of the high level (only with burst signals).

INTERVAL

Sweep is two-dimensional, the 2nd sweep parameter is the interval time (only with burst signals).

Note: *With two-dimensional sweeps of "ON TIME" and "INTERVAL", the minimum value of "INTERVAL" must exceed the maximum "ON TIME" value. With normal sweep, this is ensured by limitation and, if required, correction of the start and stop values with entry already. However, with list sweep, the user should make sure that this condition is met in the lists used, since a required, automatic correction is not carried out until the sweep is running - thus, unexpected results may be obtained.*

Note: *Theoretically, the same parameter may be entered for the X and Z axes (e.g., VOLT in both directions) - and this is not prohibited in the operator surface. This does, however, not make sense in normal practical use*

Spacing

With normal sweep only
(Sweep Ctrl → AUTO SWEEP or Sweep Ctrl → MANU SWEEP);
Determine the sweep range spacing.

LIN POINTS

The sweep range is linearly divided by a number of points to be specified. The number is entered under menu item "Points".

LIN STEPS

Beginning from "Start", the sweep range is divided into intervals using a linear step size to be specified under menu item "Step".

LOG POINTS

The sweep range is logarithmically divided by a number of points to be specified. The number is entered under menu item "Points".

LOG STEPS

Beginning from "Start", the sweep range is divided into intervals using a logarithmic step size to be specified under menu item "Step" (multiplier without unit)

Note: *No conversion is performed when switching from ... POINTS to ...STEPS and vice versa; the set values are retained in the back-ground. The numeric value for "STEP" remains the same when switching between LIN STEPS and LOG STEPS.*

Start

With normal sweep only
(Sweep Ctrl → AUTO SWEEP or Sweep Ctrl → MANU SWEEP)
Enter the start value for the (above) sweep parameter.
Specified range, unit and resolution: as for the appertaining sweep parameter.
If a start value is entered that is identical with the stop value, the stop value is automatically loaded with the old start value.
In this way, the sweep direction can be easily reversed by means of a single entry.
Note: *The start value of the sweep parameter is set in the instrument hardware with entry already (not with starting the sweep). The settling time with starting the sweep can thus be minimized.*

Stop

With normal sweep only
(Sweep Ctrl → AUTO SWEEP or Sweep Ctr → MANU SWEEP)
Enter the stop value for the (above) sweep parameter
Specified range, unit and resolution: as for the appertaining sweep parameter.
If a stop value is entered that is identical with the start value, the start value is automatically loaded with the old stop value.
In this way, the sweep direction can be easily reversed by means of a single entry.

Points

With normal sweep only
(Sweep → AUTO SWEEP or Sweep Ctrl →MANU SWEEP) and
Spacing → LIN POINTS or Spacing → LOG POINTS selected.

Specified range: 2 to 1024.
Units: None (integer)

Enter the number of sweep points for the (above) sweep parameter. The sweep range is divided into (points - 1) steps. 2 points at least (start and stop value) are required.

Step

With normal sweep only
(Sweep Ctrl → AUTO SWEEP or Sweep Ctrl → MANU SWEEP) and
Spacing → LIN STEPS or Spacing → LOG STEPS selected.

Enter the step size for the (above) sweep parameter.

With *linear* step, the absolute step size is always entered, i.e., the number value is positive even, if the start value exceeds the stop value.

With logarithmic step, the multiplication factor is entered, which is required for each sweep point to obtain the next sweep point. If start and stop value are interchanged (reversal of the sweep direction), the reciprocal value is constituted.

Specified range: see operator guidance line. The step size is to be selected as high as to result in not more than 1023 individual steps.

Unit and resolution: With linear spacing as for the appertaining sweep parameter. With logarithmic spacing, no unit can be entered (factor without unit).
Exception: *In the case of voltage sweeps (x-axis Volt), the logarithmic scaling can be entered either as a factor or in dB.*

.

FREQ FILE

With list sweeps only (Sweep Ctrl → AUTO LIST or
Sweep Ctrl → MANU LIST)

Enter a file name for the frequency list. For the entry of file names see 2.3.2 Data Entry

The signal frequency (SINE, SINE BURST, SINE^2 BURST), the useful frequency (MOD DIST) or the center frequency (DFD) is swept.

VOLT FILE

With list sweeps only (Sweep Ctrl → AUTO LIST or
Sweep Ctrl → MANU LIST)

Enter a file name for the amplitude list. For the entry of file names see 2.3.2 Data Entry

The signal voltage (SINE, SINE BURST, SINE^2 BURST) or the total voltage (MOD DIST, DFD) is swept.

ONTIM FILE

With list sweeps only (Sweep Ctrl → AUTO LIST or Sweep Ctrl → MANU LIST)

Enter a file name for the "ON-time" list of burst signals. For the entry of file names see 2.3.2 Data Entry

The burst duration (SINE BURST, SINE^2 BURST) is swept.

INTV FILE

With list sweeps only (Sweep Ctrl → AUTO LIST or Sweep Ctrl → MANU LIST)

Enter a file name for the interval list of burst signals. For the entry of file names see 2.3.2 Data Entry

The burst interval (SINE BURST, SINE^2 BURST) is swept.

2.5.4.3 SINE

Frq Offset

See 2.5.4.1 Common Parameters for the Generator Signals.

Dither

For digital generators only;
See 2.5.4.1 Common Parameters for the Generator Signals.

PDF

For digital generators only;
See 2.5.4.1 Common Parameters for the Generator Signals.

Low Dist

(Low-distortion generator) for the analog generator only.

Activating/Deactivating the low-distortion generator (see 2.5.1 Selecting t Generator)

ON

(with UPL-B1 option only);
the sine is generated by the low-distortion generator.

OFF

The sine is generated by the universal generator.

DC Offset

see 2.5.4.1.2 Common Parameters for All Generator Functions.

SWEEP CTRL

see 2.5.4.2 Sweeps

Frequency

Entry of the sine frequency; can be used as sweep parameter.
Specified range: 10 Hz to f_{max}
f_{max} generator-dependent; cf. 2.5.1 Selecting the Generator
Resolution: 1 MHz
Unit: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Equalizer

see 2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM

The sine voltage is corrected.

ON

Equalizer switched on. Menu item "Equal. file" is activated, i.e. the file indicated there is loaded.

OFF

Output voltage not affected.

Equal. file

(Equalizer file)
with Equalizer → ON only;
see2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM

Voltage

Entry of the sinewave amplitude; can be used as sweep parameter; see 2.3.2 Data Entry

Specified range:
- digital: 0 to 1 FS (audio data or phase mode)
  0 to 2.5 UI (jitter mode)
  0 to 7.071 V_{rms} (common mode)
- analog: 0 to 10 V_{rms} for UNBAL
  0 to 20 V_{rms} for BAL

Note: *Voltage limitation of the rms value by means of menu item "Max Volt", see 2.5.2 Configuration of the* Analog Generator */ 2.5.3 Configuration of the* Digital Generator

Units:

digital (audio data or phase mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr

digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr

analog and digital common mode:
V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

Peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;

2.5.4.4 MULTISINE

Up to 17 single sine voltages can be superposed on each other.

The phase angles of the single sine voltages are automatically optimized such that the maximum total peak value is as low as possible. The resulting total peak value thus being frequency-dependent, the voltage may increase when varying individual frequencies. The set maximum voltage ("Max volt", see 2.5.2 Configuration of the Analog Generator / 2.5.3 Configuration of the Digital Generator) is however never exceeded since the worst case is taken as the basis for linear superposition when entering the single voltages.

Further ***special multi-tone signals*** are selected using the functions

- MOD DIST (2 sinewave amplitudes with the ratios 1:1 to 10:1)
- DFD (2 equivalent sinewave amplitudes)
- SINE (1 sinewave with any amplitude)
- RANDOM, domain FREQ (7488 sinewave lines at fixed frequency offset with any amplitude)

With the first 3 functions, a "Frq Offset" or (with digital generator), in addition, "Dither" with "PDF" can be set.

DC Offset

see 2.5.4.1.2 Common Parameters for All Generator Functions

Spacing

Set the frequency spacing:

USER DEF

The value entered is corrected to the next settable value.
The specified range depends on the selected generator and its sample rate (see 2.5.1 Selecting the Generator):
Lower limit:
- ANLG: 2.9 Hz
- DIG instruments: Int. sample frequency / 16384

Units: Hz, kHz

ANLR TRACK

The value for the FFT analysis frequency spacing is automatically adopted. The value is also displayed in the ANALYZER panel under "FFT:Resolution" (see 2.6.5.12 FFT). This setting is ideal for an analysis using the rectangular window. With no FFT selected in the analyzer, the setting is rejected (error message!).

Equalizer

see **2.5.4.1.3 Common Parameters for** SINE, DFD, MULTI, RANDOM

Each active frequency line is corrected.

ON

Equalizer switched on. Menu item "Equal. file" is activated, i.e. the file indicated there is loaded.

OFF

The output voltage of all frequency lines is not affected.

Equal. file

(Equalizer file)
with Equalizer → ON;
see 2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM

Mode

Select the input mode for the individual sine voltages:

EQUAL VOLT

The same amplitude applies for each single sine; it is entered as "Volt No1".

DEFINE VOLT

An individual amplitude can be defined for each single sine.

Crest Fact

Selects the algorithm for determining the phase of individual sinewaves and thus of the crest factor of the complete signal.
This menu item is only displayed with option UPL-B6 installed.

OPTIMIZED

The crest factor is automatically *minimized* by internally optimizing the individual phases.

VALUE:

Definition of *desired crest factor*. The phase of the individual sinewaves are modified internally so that the resulting crest factor closely approaches the desired value. The accuracy of this method depends on the number of lines.

DEFINE PHAS

Entry of *phases* of all active sine lines.

No of sine

Specified range: 1 to 17
Units: none

Entry of number of desired tones, i.e. the number of sines to be edited. In EQUAL VOLT mode, the entry also influences the maximum amplitude that can be entered for a single sine tone (see "Volt No (i) ").

For a better overview, settings for up to 17 frequencies and levels are not made in the GENERATOR panel, but in a special dialog window, which is opened automatically with selection of "No of sine" or command "Choice ..." below. In this window, the individual frequency, phase and level menu items can be copied into the STATUS panel by ticking them off. Subsequent to closing the window, they can be displayed and entered in the STATUS panel.

Choice ...

Opens a special dialog window where the individual sine frequencies and levels can be displayed and entered in a clearly arranged form.

All frequency and level items marked in the menu of this window are transferred into the STATUS panel where they can be displayed and entered even after this window has been closed.

Note: *The dialog window described here is also automatically opened when "No of sine" is entered.*

Freq No (i)

Enter the sinewave frequency i (i = 1 to 17)

Specified range: f_{min} to f_{max} (depending on generator)
f_{min}: Value from spacing
f_{max}: see 2.5.1 Selecting the Generator

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

The single frequencies may lie as close to each other as desired or may even be superposed on each other (taking the resolution into account).

Phase No (i)

Entry of phase of individual sinewave i (i = 1 to 17)

This menu item is only displayed when software option UPL-B6 is installed and DEF PHASE was selected as crest factor.

The reference point is the assumed time T0, where all sinewaves start with the phase 0.
If sinewave No. 1 is to be used as reference frequency, it must be assigned the phase 0.

Specified range: 0 to 360°
Unit: ° or RAD

If two or more individual lines have the same frequency, i.e. are superimposed, the first of the two lines determines the (common) phase which is assigned to all subsequent frequency lines.

Volt No (i)

Enter the sinewave amplitude i (i = 1 to 17)

Specified range: the total voltage of V_{max} is available for all single sines (n = "No of sin", 1 to 17) and the DC offset:

digital (audio data or phase mode):
V_{max} = 1 FS
(jitter mode): V_{max} = 2.5 UI
(comm mode): $V_{max} = 7.071\ V_{rms}$
analog: $V_{max} = 10\ V_{rms}$ for UNBAL
$V_{max} = 20\ V_{rms}$ for BAL

Note: *Voltage limitation of the rms value by menu item "Max volt", see 2.5.2 Configuration of the Analog Generator / 2.5.3 Configuration of the Digital Generator*

V_{max} is split up into the single sine voltages as follows:

- in EQUAL VOLT mode, any sine may be as large as (V_{max} DC)/n
- in DEFINE VOLT mode, any sine may be as large as the difference between (V_{max} DC) and the sum of all other active single sines

Units:
digital (audio data or phase mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr
analog and digital common mode:
V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r | dBu | dBV | dBr | dBm | Δ%V | ΔV | ΔmV | ΔµV

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;

Total Gain

Enter an amplification factor (in dB), which allows the rms value resulting from the superimposition of the single voltages to be increased or decreased.

Unit: dB

TOTAL PEAK

Read only, no input field
Indicates total peak value of multi-tone signal. The value is usually below of the single peak values due to internal phase optimization

Units: digital (audio data or phase mode):
FS | %FS | dBFS | LSBs | bits
digital (jitter mode):
UI | %UI | dBUI | ppm | ns
analog and digital common mode:
V | mV | µV | dBu | dBV | dBm

TOTAL RMS

Read only, no input field (only analog)
Indicates total rms value of multi-tone signal.

Units: V | mV | µV | dBu | dBV | dBr | V/V_r | Δ%V | ΔV | ΔmV | ΔµV

2.5.4.5 SINE BURST

Sine periodically varying between high and low level.

DC Offset

see 2.5.4.1.2 Common Parameters for All Generator Functions

SWEEP CTRL

see 2.5.4.2 Sweeps.

FREQUENCY

Entry of the sine frequency; can be used as sweep parameter; see 2.3.2 Data Entry

Specified range: 10 Hz to f_{max}
f_{max} depending on generator; see 2.5.1 Selecting the Generator

Resolution: 1 MHz

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Side-effect: ON TIME is adjusted, if required.

VOLTAGE

Entry of the high-level sine amplitude, i.e. the amplitude during burst time; can be used as sweep parameter; see 2.3.2.5.

Specified range: 0 to V_{max}
digital: V_{max} = 1 FS
analog: V_{max} = 10 V_{rms} for UNBAL
V_{max} = 20 V_{rms} for BAL

Note: Voltage limitation of the rms value by menu item "Max volt", see 2.5.2 Configuration of the Analog Generator / 2.5.3 Configuration of the Digital Generator

Units: digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
analog:
V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;
Side effect: Low Level is adjusted, if required.

Low Level

Enter the low-level sine amplitude, i.e. the amplitude during OFF time.

Specified range: 0 to high level (VOLTAGE)
Units:

digital (audio data mode):

FS | %FS | dBFS | LSBs | bits | Δ% | dBr | %on | dBon

analog:

V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r | dBu | dBV | dBr | dBm | V/on | %on | dBon | Δ%V | ΔV | ΔmV | ΔµV

As to the unit: *In addition to the standard voltage specifications (absolute or relative to the reference value), further relative units referring to high level can be used. They are*

%on, dBon; in the analog range also V/on

If a unit of this kind is selected, the ratio

"low level : high level"

is always kept constant when the high level is varied. This means that changing VOLTAGE (also during a sweep) changes the low level, too. With all other units, varying VOLTAGE affects the low level only when VOLTAGE becomes smaller than the low level.

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;

ON TIME

Entry of the burst duration, i.e. the time during which the sine has its high level; can be used as sweep parameter.

Specified range:	lower limit:	(1 sample)
	analog:	t_{min} = 20.83 µs
	digital:	t_{min} = 1 / $sample_{Frq}$
	upper limit:	60 s - t_{min}
Unit:	s | ms | µs | cyc | kcyc | Mcyc	

Side effect: *Entering a burst duration exceeding the length of an interval causes the interval length to be increased to burst duration.*

Note as to the unit: *Apart from standard time specifications, the burst duration can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles - and not the burst time - remaining constant when the frequency is changed, i.e. increasing the frequency decreases the duration of the burst signal. If INTERVAL is not specified in cycles, the ratio ON–TIME : INTERVAL is reduced.*

INTERVAL

Entry of the burst interval length; can be used as sweep parameter.

Specified range: lower limit: set burst duration.
upper limit: 60 s

Units: s | ms | µs | cyc | kcyc | Mcyc | min

Note as to the unit: *Apart from standard time specifications, the burst interval can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles - and not the interval time - remaining constant when the frequency is changed, i.e. increasing the frequency decreases the interval of the burst signal, If the ON TIME is not specified in cycles, the ratio ON–TIME : INTERVAL is increased.*

Note: *If generator settings are modified or a measurement is (re-)started, the generator is automatically restarted and starts the interval (considering the Burst On Delay) with ON TIME, i.e. with High Level.*

BurstOnDel

(Burst on delay)

When starting the generator (e.g., subsequent to changing or acknowledging the function) or starting the measurement, the burst signal normally adopts the "burst on"-state, i.e. the high level. Certain applications, however, require the high level state to be delayed, e.g., in order to trigger to the high level. The start delay of the burst signal is intended to be used for these applications; the generator puts out the low level.

Specified range: 0 to 60 s

2.5.4.6 SINE² BURST

Sine²-wave signal which is periodically switched on and off. Either positive or negative pulses (also partial pulses) can be generated (by entering a negative voltage). Typically, the signal is not DC-free.

DC Offset

see 2.5.4.1.2 Common Parameters for All Generator Functions

SWEEP CTRL

see 2.5.4.2 Sweeps

FREQUENCY

Entry of the sine²-wave frequency; can be used as sweep parameter; see 2.3.2 Data Entry

Specified range: 10 Hz to f_{max}
f_{max} depending on generator;
see 2.3.2 Selecting the Generator

Units: Hz | kHz | ΔHz | ΔkHz | f/f_r | Δ%Hz | Terz Oct | Dec

Resolution: 1 MHz

Note: The period of this signal is defined as the time required for a pulse.

Side effect: "ON TIME" is adjusted, if required.

VOLTAGE

Entry of the sine²-wave amplitude; can be used as sweep parameter.

Specified range: 0 to V_{max}
digital: V_{max} = 1 FS
analog: V_{max} = 10 V_{rms} for UNBAL
V_{max} = 20 V_{rms} for BAL

Units:
digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
analog:
V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

Note: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generator / 2.5.3 Configuration of the Digital Generator*

As to the unit: When entering negative voltages, the pulse is inverted. Conversion into logarithmic units (dBFS, dBu, dBr, dBV) is not possible in this case.

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;
V_{rms} is the rms value during pulse time, the level during OFF time is not considered when calculating the rms value.

ON TIME

Entry of the pulse duration, i.e. the time the sine^2 is switched on; can be used as sweep parameter; see 2.3.2 Data Entry

Specified range:	lower limit:	(1 sample)
	analog:	t_{min} = 20.83 µs
	digital:	t_{min} = 1 / $sample_{frq}$
	upper limit:	60 s - t_{min}
Units:		s | ms | µs | cyc | kcyc | Mcyc | min

***Side effect**: Specifying a burst duration longer than the interval length causes the latter to be increased to burst duration.*

***As to the unit:** Apart from standard time specifications, the pulse duration can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles - and not the pulse time - remaining constant when the frequency is changed, i.e. increasing the frequency decreases the pulse duration. If the INTERVAL is not entered in cycles, the ratio ON–TIME : INTERVAL is reduced.*

INTERVAL

Entry of the interval length; can be used as sweep parameter; see 2.3.2 Data Entry

Specified range:	lower limit:	set burst duration
	upper limit:	60 s
Units:		s | ms | µs | cyc | kcyc | Mcyc | min

***As to the unit:** Apart from standard time specifications, the pulse interval can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles - and not the pulse time - remaining constant when the frequency is changed, i.e. increasing the frequency decreases the interval length of the burst signal. If the ON TIME is not entered in cycles, the ratio ON–TIME : INTERVAL increases.*

***Note**: If generator settings are modified or a measurement is (re-)started, the generator is automatically restarted and starts the interval (considering the Burst On Delay) with ON TIME.*

BurstOnDel

(Burst On Delay)

When starting the generator (e.g., subsequent to changing or acknowledging the function) or starting the measurement, the burst signal normally adopts the “burst on“-state, i.e. the high level. Certain applications, however, require the high level state to be delayed, e.g., in order to trigger to the high level. The start delay of the burst signal is intended to be used for these applications; the generator puts out the low level.

Specified range: 0 to 60 s

2.5.4.7 MOD DIST (Two-tone Signal to SMPTE)

Superposing 2 sinewave signals: low-frequency interfering signal and high-frequency useful signal; interfering signal is 1 to 10 times stronger than useful signal.

For intermodulation measurements to SMPTE (Society of Motion Picture and Television Engineers) and modulation distortion analysis to .

Frequencies

- Recommendation DIN 45403, sheet 4: or DIN-IEC 268-3:
  interfering signal
  f1 < = 1.4 x lower limit frequency of DUT
  f1 > = 31.5 Hz
  useful signal f2
  f2 > = 0.7 x upper limit frequency of DUT
  f2 > = 8 x f1

- SMPTE standard:
  interfering signal: f1 = 60 Hz
  useful signal: f2 = 7 kHz

Amplitude ratio interfering signal : useful signal:
4:1 (SMPTE); to DIN, 10:1 is also possible

With the LDG option fitted, the useful signal in the analog range can be generated by the universal generator or, alternatively, by the low-distortion generator.

Notes:

- *For intermodulation measurements to MOD DIST, an appropriate measurement function is to be set in the ANALYZER panel (see 2.6.5.8).*
- *If the selection "Function tracking Gen → Anl" is ticked off in the OPTIONS panel under menu item "Param Link", the measurement function MOD DIST is switched on in conjunction with the function changeover of the generator to MOD DIST:*

Frq Offset	See 2.5.4.1 Common Parameters for the Generator Signals
Dither	For digital generators only; see 2.5.4.1 Common Parameters for the Generator Signals
PDF	For digital generators only; see 2.5.4.1 Common Parameters for the Generator Signals
DC Offset	see 2.5.4.1 Common Parameters for the Generator Signals
SWEEP CTRL	see 2.5.4.2 Sweeps

UPPER FREQ

Entry of the er the useful frequency; can be used as sweep parameter. see

Specified range:240 Hz to f_{max}

f_{max} depending on generator; see 2.5.1

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Resolution: 1 MHz (50 Hz for DIG 768 kHz)

LOWER FREQ

Entry of the interfering frequency; can be used as sweep parameter.

Specified range:30 Hz to UPPER FREQ / 8

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Resolution: 1 MHz

VOLT LF:UF

Enter the ratio interfering level : useful level as a real number.

Specified range:1.0 to 10.0

In the analog range, this ratio affects the level of the total rms voltage which can be input via "TOTAL VOLT".

Unit: none

TOTAL VOLT

Entry of the total amplitude of both sinewave signals; can be used as sweep parameter.

Specified range:

digital: 0 to 1 FS

analog: 0 to 10.964 V_{rms} for UNBAL

0 to 21.927 V_{rms} for BAL

Note: *The selectable analog voltage depends on the voltage ratio "Volt LF:UF"; specifications refer to a voltage ratio of 10:1.*

Note: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generator / 2.5.3 Configuration of the Digital Generator*

Units:

digital (audio data mode):

FS | %FS | dBFS | LSBs | bits | Δ% | dBr

analog:

V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |

dBu | dBV | dBr | dBm |

Δ%V | ΔV | ΔmV | ΔµV

In the analog range, the maximum peak voltage is $\sqrt{2}$ x 10 V (UNBAL) or $\sqrt{2}$ x 20 V (BAL). Hence, the following restriction applies:

$V_{pp} \leq 28{,}284\ V_{pp}$ (UNBAL) or

$V_{pp} \leq 56{,}569\ V_{pp}$ (BAL)

$V_{pp} = V_{1pp} + V_{2pp}$

The total voltage is divided into useful signal and interfering signal in a (selectable) ratio. The maximum total rms voltage, which is obtained from the square sum of the single rms values, thus depends on the level ratio interfering signal : useful signal. The specifications for the specified range stated above are relative to the ratio 10 : 1. The closer the ratio comes to the value 1 : 1, the lower the maximum obtainable total rms voltage. With 1 : 1, it is 7,0711 V_{rms} (UNBAL) or 14,142 V_{rms} (BAL).

As a rule, the relationship between total peak-to-peak voltage and total rms voltage *can be expressed as follows:*

$$V_{pp} = \frac{V_{eff} \times 2 \times \sqrt{2} \times (k+1)}{\sqrt{(k^2+1)}}; \qquad k = \text{"VOLT LF:UF"}$$

2.5.4.8 DFD (Difference Frequency Distortion)

Two closely spaced sinewave signals of the same amplitude; for intermodulation measurements (DFD method to DIN-IEC 268-3, former DIN 45403, Sheet 3).

With the LDG option fitted, the low-frequency sinewave in the analog range can be produced by the function generator or, alternatively, the low-distortion generator.

Note: *For intermodulation measurements to DFD, an appropriate measurement function is to be set in the ANALYZER panel (see 2.6.5.9).*

Note: *If the selection "Function tracking Gen → Anl" is ticked off in the OPTIONS panel under menu item "Param Link", the measurement function MOD DIST is switched on in conjunction with the function changeover of the generator to MOD DIST:*

Frq Offset

see 2.5.4.1 Common Parameters for the Generator Signals

Dither

For digital generators only;
see 2.5.4.1 Common Parameters for the Generator Signals

PDF

For digital generators only;
see 2.5.4.1 Common Parameters for the Generator Signals

DC Offset

see 2.5.4.1.2 Common Parameters for All Generator Functions

Equalizer

see 2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM . Each of the two difference tone frequencies is corrected.

ON

Equalizer switched on. The menu item "Equal. file" is loaded, i.e. the indicated file is loaded.
It may happen that the two (equal) sine voltages are weighted with different correction factors so that they are no longer recognized as DFD signal by the analyzer. If an error message of this kind is displayed, switch to the IEC 118 measurement mode which is more tolerant to differences of the DFD lines.

OFF

The output voltage of the two difference tone frequencies is not affected.

Equal. file

(Equalizer file)
with Equalizer → ON only;
see 2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM .

Mode

Selection of entry mode for DFD frequencies.

IEC 268

Entry of center frequency (MEAN FREQ) and difference frequency (DIFF FREQ). If a frequency sweep is selected (for the X or Z axis), the center frequency is swept.

IEC 118

Entry of upper DFD frequency (UPPER FREQ) and difference frequency (DIFF FREQ). If a frequency sweep is selected (for the X or Z axis), the UPPER FREQ is swept.

Note: *When measuring the DFD, one of the two standards can be selected under the menu item "Meas Mode".*

SWEEP CTRL

see 2.5.4.2 Sweeps

MEAN FREQ

Entry ofer the mean frequency; can be used as sweep parameter.

Specified range:200 Hz to (f_{max} - 500 Hz)
f_{max} depending on generator;
see 2.5.1 Selecting the Generator

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Resolution: 1 MHz;

DIFF FREQ

Enter the frequency difference between both sines

Specified range:80 Hz to 0.55 * MEAN FREQ, max. 1 kHz
f_{min} depending on generator;
see 2.5.1 Selecting the Generator

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Resolution: 1 MHz

Rec. to DIN-IEC 268-3: 80 Hz

TOTAL VOLT

Entry of the total amplitude of both sinewave signals; can be used as sweep parameter, see 2.3.2.

Specified range:digital: 0 to 1 FS
analog: 0 to 8.485 V_{rms} for UNBAL (BNC)
0 to 16.971 V_{rms} for BAL (XLR)

Note: Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the *Analog Generator* / 2.5.3 Configuration of the *Digital Generator*

Units:

digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr

analog:
V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

The maximum peak-to-peak voltage in the analog range is $\sqrt{2}$ x 10 V (UNBAL) or $\sqrt{2}$ x 20 V (BAL). Hence the following limitation applies:

$U_{pp} \leq 28{,}284\ V_{pp}$ (UNBAL) or

$U_{pp} \leq 56{,}568\ V_{pp}$ (BAL)

$U_{pp} = U_{1pp} + U_{2pp}$

With two equivalent single voltages $U_{1pp} = U_{2pp}$, the maximum permissible total rms voltage is:

$$U_{eff} = \sqrt{\left(\frac{U_{1PP}}{2\sqrt{2}}\right)^2 \cdot 2} = \frac{U_{1pp}}{2} = \frac{U_{pp}}{4}$$

2.5.4.9 Random (Pseudo Noise)

Set generator signals which have the same or similar characteristics as noise (e.g. closely spaced sine lines in the frequency domain). There are two ways of defining these signals:

- Specify the amplitude density distribution in the time domain (Domain: TIME)
- Specify the amplitude frequency distribution in the frequency domain (Domain: FREQ)

This function is available in all generators.

DC Offset

see 2.5.4.1.2 Common Parameters for All Generator Functions

Domain

Selection of domain for definition of the noise signals

FREQ

Sine lines with settable amplitudes are generated and superposed on each other using defined frequency spacings to produce the output signal. In order to minimize the resulting peak value of the signal, each line is phase-optimized relative to the other lines. Minimum form factors (=peak/rms) can thus be obtained. Depending on the selectivity of the analyzer, the output signal is not displayed as a sequence of single lines, but as a noise signal with continuous level above the frequency.
The frequency-defined noise allows for generating up to 7488 single tones with any amplitude (multitone).

Special application:
When the frequency spacing of the sine lines generated here **exactly** matches the analysis spacing used for the FFT, an FFT analysis is feasible without leakage. A selectivity of one line can thus be obtained with the square window. The setup consisting of this generator and analyzer allows you to precisely determine the frequency response of a device under test at one go. (see 2.6.7.3 Fast Frequency Response Measurement

Note: *As the optimization is very compute-bound, a few seconds of computing time before the output is started may be required by the generator, especially with small frequency spacings and wide noise band. → Status display: "GEN: BUSY". Entering data while GEN: BUSY is being displayed aborts the computations and the generator enters the GEN:HALTED state. The generator restarts automatically.*

TIME

In this mode, noise signal generation is effected by nested random functions which have been optimized to produce evenly distributed noise. Periodicity is the case only after a runtime of at least 1 day.

Spacing

Definition of the frequency spacing, i.e. the space between the individual frequency lines:
(displayed with domain = Freq only)

USER DEF

The frequency spacing can be set manually. The value entered is corrected to the next settable value. The limits and settable frequency values depend on the sample rate (see 2.5.1 Selecting the Generator) and the selected generator. The lower frequency limit for the digital instruments is the ratio

system clock rate / 16384

Units: Hz, kHz

ANLR-TRACK

The value specified for the FFT analysis spacing is automatically adopted. The value is also displayed in the ANALYZER panel under "FFT:Resolution" (see 2.6.5.12 FFT). This setting is ideal for an analysis using the rectangular window. With no FFT selected in the analyzer, the setting is rejected (error message!).

Shape

(displayed with Domain = FREQ only)

Specify the function which is used to determine the amplitudes of the single sine lines.

WHITE

All the sine lines between start value (see below) and stop value have the same amplitude.

PINK

The amplitude of the sine lines between start and stop value is proportional to $\sqrt{1/f}$

THIRD OCT

As PINK, however band-limited to $^1/_3$ octave = 1 third-octave (TOCT) with settable mean frequency ("third-octave noise").

FILE

The amplitudes of the single lines are set using floating numbers which are read from a file.

Shape File

There are two different file formats for Domain FREQ: the ASCII file with the extension .FTF which is generally written by the user and the equalization file with the extension VEQ! which is normally generated from trace data (sweep or FFT). The latter is also offered in the basic setting in the file panel. It can however be overwritten by the user. - For Domain TIME, a file can't be loaded.

File format 1:
The file is a pure ASCII file where the amplitudes of the single frequency lines starting from 0 Hz are entered as floating numbers; the space between the lines is determined by "Spacing" which can be entered in the panel. The numbers specify only the amplitude ratio between the lines and not the output amplitude (which is determined after phase optimization using "VOLTAGE PEAK"). The file must have a line with the keyword `'FREQUENCY_FILE'` before the numbers. Comment lines begin with '#' and are allowed anywhere. No difference is made between upper-case and lower-case letters.
The preset type of file is '.FTF' (= frequency table file).

Example: `'r&s_exam.ftf' in directory C:\UPL\USER.`

File format 2:

The EQUALIZATN file in the file panel which was generated with Store Trace/List is used. The inverted form of a frequency response is generally used (Invert 1/n ON) so that, using this "pre-distorted" spectrum, a flat frequency response can be achieved after the DUT. Both of the formats ASCII and REAL can be loaded, the standard file extension is: VEQ!

Using an equalization file which was obtained from an FFT:
Feed the noise signal from the generator into the DUT, set an FFT with a rectangular window such that a closed trace (comparable with a sweep curve) results and save the FFT as an Equalization file.
The essential settings in detail from left to right:

GENERATOR Panel:		ANALYZER Panel:		FILE Panel	
FUNCTION	RANDOM	FUNCTION	FFT	Store	EQUALIZATN
Domain	FREQ	Window	RECTANGULAR	Invert 1/n	ON
Spacing	ANLR TRACK			Filename	XXX.VEQ
Shape	WHITE				

To display the straightened trace, feed the noise signal including the shape file XXX.VEQ into the DUT.

GENERATOR Panel:	
FUNCTION	RANDOM
Domain	FREQ
Spacing	ANLR TRACK
Shape	FILE
Shape File	XXX.VEQ

Equalizer

(displayed with FREQ domain only)

see 2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM . Each frequency line is corrected.

ON

Equalizer switched off. The menu item "Equal. file" is activated, i.e. the file indicated there is loaded.

The set voltage (peak or RMS) and the calculated crest factor refer to the *non-equalized* total signal (as is the case with single and multi-tone signals). Therefore, the voltage measured at the outputs is not identical with the values for VOLT PEAK and VOLT RMS indicated in the GENERATOR panel.

OFF

The output voltage of all frequency components of the noise signal is not affected.

Equal. file

(Equalizer file)

with Equalizer → ON only;
see 2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM .

Crest Fact

(displayed with Domain Freq only)

Selects the algorithm for determining the phase position of the individual frequency lines and thus the crest factor of the complete signal.

OPTIMIZED

Automatic *minimization* of crest factor by internally optimizing the individual phases.

VALUE:

Presetting a *desired crest factor.* The phase of the frequency lines is modified internally so that the resulting crest factor closely approaches the desired value. The accuracy of this method depends on the total number of lines thus spacing and frequency range

Lower Freq

(is displayed with Domain = FREQ, only)
Set the lower limit of the range for generated noise (with Shape WHITE and PINK). The limits for this setting are
f_{ugr} = 1 x spacing

f_{ogr} =117/256 x sampling rate - 1 x spacing

The values entered are rounded to integer multiples of "spacing".

Upper Freq

(is displayed with Domain = FREQ, only)

Set the upper limit of the range for generated noise (with Shape WHITE and PINK). The limits for this setting are
f_{ugr} = Lower freq + 1 x spacing
f_{ogr} =117/256 x sampling rate

The values entered are rounded to integer multiples of "spacing"..

MEAN FREQ

(displayed with Domain = FREQ, Shape THIRD OCT))

Set the mean frequency at $^1/_3$ octave. The output starts at the line next to the mean frequency/ 1.12246 and ends with the line next to the mean frequency x 1.12246.

VOLT PEAK

Set the peak output level.

VOLT PEAK and VOLT RMS are coupled via the crest factor (which is constant for a specific signal). A change of VOLT PEAK therefore immediately affects the figure for VOLT RMS. If the crest factor is changed, RND PEAK will remain unchanged.

Specified range: 0 to V_{max}

digital: V_{max} = 1 FS
V_{max} = 10 V (Mode Common)
V_{max} = 2,5 UI (Mode Jitter)

analog: V_{max} = 14,142 V für UNBAL
V_{max} = 28,284 V für BAL

Units:

digital (audio data or phase mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr

digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr

analog and digital common mode:
V | mV | µV | V/V_r | dBu | dBV | dBr | dBm | Δ%V | ΔV | ΔmV | ΔµV

VOLT RMS

Setting of rms output voltage (in the analog generator only).

VOLT PEAK and VOLT RMS are coupled via the crest factor (which is constant for a specific noise signal). A change of VOLT RMS therefore affects the VOLT PEAK value.

Units: V | mV | µV | V/V_r | dBu | dBV | dBr | dBm | Δ%V | ΔV | ΔmV | ΔµV

Note: *Entry of VOLT RMS is only possible when the generator is RUNNING. Since the crest factor is not yet known during calculation of the noise signal (GEN BUSY), the entry is at first rejected and the voltage 0.0 is entered. To ensure that the generator outputs a noise signal of correct (peak) amplitude after the calculation, VOLT PEAK should be entered, which is possible any time.*

PDF

(displayed with domain = TIME)

(PDF = probability density function) Select the amplitude distribution function of the output signal:

GAUSS Normal (Gaussian) distribution which is cut off at triple the σ-value of the Gaussian distribution curve.

TRIANGLE Triangle distribution from -peak to +peak.

EQUIVALENT Equivalent distribution from -peak to +peak.

Note: *The Gaussian and triangle distributions are obtained by calculation on the basis of equivalent distribution.*

2.5.4.10 Arbitrary (User-Programmable Signal)

Outputs a user-defined waveform. Four formats with different origins and lengths are supported:

1. **TTF format:** ASCII file with a maximum of 16384 samples. Each sample is entered as a sequence of numbers (FLOAT format). In the waveform, the value 1.0 is equivalent to the peak voltage given in the VOLTAGE PEAK field. The numeric values in the file must be preceded by the key word `TIMETAB_FILE`. Comment lines start with # and may be inserted wherever desired. No distinction is made between uppercase and lowercase letters. The recommended file extension .TTF (=time table file) is the default setting.
2. **AWD format:** Output file from the arbitrary waveform designer. As it is a TTF file, it may contain a maximum of 16384 samples. The recommended file extension .AWD is the default setting.
3. **WAV format:** supports 8bit and 16bit format; 16 bit format requires models 06 / 66 or higher. It is a standardized waveform format that is widely used in the PC world (sound cards). WAV files may be stored at any desired sampling rate. However, for use in UPL it should match the selected sampling rate (48 kHz only for analog). If necessary, the WAV file can also be converted to 48 kHz - which is supported by analog and digital applications - by means of a suitable sound-card tool. WAV files of any length are accepted, so they are not restricted to 16384 samples. To load and display large WAV files in 16-bit format, however, the RAM needs to be expanded to enhance performance.
4. **CPR format:** This is a special compressed waveform format which accepts any word width up to 16 bits and can therefore be matched to the performance of UPLs with a 486 processor. A tool is available for generating CPR files by compressing TTF and AWD files to the required word width (13 bits as standard, 4 to 16 bits can be selected). CPR-files include information about maximum peak level and - if available in source files - about sampling frequency. On playback the signal will be attenuated so the selected generator peak level will be reached by the highest volume. As with WAV files, it is best to expand the RAM when CPR files are used.

Notes:

- *Arbitrary waveform designers are software packages for generating all types of waveforms and run on AT-compatible PCs (as on the UPL, for example).*
- *The samples are output at the selected sampling rate. If the file was generated for a different sampling rate, the output frequencies will be changed accordingly.*
- *The entered waveform is continuously output (no gaps), independently of the actual number of samples. The number of samples is determined by the number of waveform points in the file.*
- *The samples in the WAV and CPR files are sent online from the harddisk or the extended memory to the DSP generator. A buffer of approx. 2 s is used in the process. If PC capacity is simultaneously used for other tasks, eg the user interface, the buffer may be emptied. In this case the generator will be muted, the buffer refilled and the file is again output from the start.*
- *If the RAM capacity available for the outputting of WAV or CPR files is insufficient, the file must be read directly from the harddisk, which results in a slower transfer rate between the CPU and DSP. As a consequence, the generator will be muted and restarted more frequently than necessary. This will not happen if:*

  ⇒ *the extended memory is enlarged by means of a RAM expansion*

  ⇒ *audio bits are reduced with the aid of the COMPRESS program*

DC Offset

see 2.5.4.1.2 Common Parameters for All Generator Functions

File name

Name of the file from which the waveform is to be loaded. All files are listed in the above formats as default. The file extensions for WAV and CPR files are compulsory, while TTF and AWD formats also accept different extensions, as these file can also be identified internally.

Example: `'r&s_exam.ttf' in directory C:\UPL\USER.`

VOLT PEAK

Set the peak output level.

VOLT PEAK and VOLT RMS are coupled via the crest factor (which is constant for a specific signal). A change of VOLT PEAK therefore immediately affects the figure for VOLT RMS.

Specified range: 0 to V_{max}

digital: V_{max} = 1 FS
V_{max} = 10 V (Mode Common)
V_{max} = 2,5 UI (Mode Jitter)

analog: V_{max} = 14,142 V für UNBAL
V_{max} = 28,284 V für BAL

Units:

digital (audio data or phase mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr

digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr

analog and digital common mode:
V | mV | µV | V/V_r | dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

VOLT RMS

Only for format AWD und TTF; Setting of rms output voltage (in the analog generator only).

VOLT PEAK and VOLT RMS are coupled via the crest factor (which is constant for a specific noise signal). A change of VOLT RMS therefore affects the VOLT PEAK value.

Units: V | mV | µV | V/V_r | dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

2.5.4.11 POLARITY (Polarity Test Signal)

Specific SINE² BURST signal with the following characteristics:

FREQUENCY: sample rate /80 (DIGITAL)
1.2 kHz (ANALOG)
ON-TIME: 1 cyc
INTERVAL: 2 cyc

The amplitude of the signal only can be selected by the user. The signal is not DC-free.

DC Offset

see 2.5.4.1.2 Common Parameters for All Generator Functions

VOLTAGE

Enter the SINE² amplitude;

Specified range:
digital: 0 to 1 FS
analog: 0 to 10 V_{rms} for UNBAL (BNC)
0 to 20 V_{rms} for BAL (XLR)

Note: Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generator / 2.5.3 Configuration of the Digital Generator

Units:
digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
analog:
V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | V/V_r |
dBu | dBV | dBr | dBm |
Δ%V | ΔV | ΔmV | ΔµV

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;

V_{rms} is the rms value during pulse time, the level during OFF time is not considered in rms value calculation.

2.5.4.12 FSK (Frequency Shift Keying)

This item can only be selected with option UPL-B33 built-in (line measurements to ITU-T O33).
Frequency shift keying generates a sequence of two different sinewave frequencies where each is output for 9 ms (baud rate 110). The data coded in this way can only be defined from option UPL-B33 or UPL-B10.
Frequency #1: 1850 Hz, logic 0
Frequency #2: 1650 Hz, logic 1

Voltage

Level of each frequency

2.5.5 Auxiliary Generator

With option UPL-B1 (low-distortion generator) fitted, an additional sinewave generator is available for producing analog or noise signals up to 110 kHz in the source mode AUDIO DATA or PHASE. Thus,

- *digital* audio data of any signal shape and an *analog* sinewave signal or
- *digital* audio data of any signal shape and a *superimposed* noise signal (jitter or common mode signal)

can be generated *simultaneously.*

The auxiliary generator has the same specifications as the low-distortion generator and its own (1-dimensional) sweep system for sweeping either the level or frequency.

AUX GEN — Activation of auxiliary generator and selection of use.

OFF — Auxiliary generator switched off; audio data are generated without a noise signal, analog outputs switched off (high-impedance).

ANALOG OUT — Audio data are generated without a noise signal. In addition to the digital signal (at the BAL, UNBAL and optical outputs) an analog signal is generated at the analog XLR connector.
Frequency and level of the analog signal can be set or swept.

COMMON MODE — A common mode signal is superimposed onto the audio data, the analog outputs are switched off (high-impedance).
Frequency and level of the noise signal can be set or swept.

JITTER — A jitter signal is added to the audio data, the analog outputs are switched off (high-impedance).
Jitter frequency and level can be set or swept.

2.5.5.1 Auxiliary Generator Used as Analog Generator

The generator can be used as a balanced or unbalanced source with one or two output channels. Different source impedances can be selected. The low-distortion generator is used, level control is via the output amplifier.

Channel(s)

Selection of output channel; disabled channels are terminated with the set output impedance.

- **OFF** — Both channels off
- **1** — Channel 1 on, channel 2 off
- **2** — Channel 2 on, channel 1 off
- **2 ≡ 1** — Same signal on both channels

Output

XLR connectors can be used as balanced (BAL) or unbalanced (UNBAL) output.

- **UNBAL** — An unbalanced signal is generated at the XLR connector; The maximum output level is 10 V.
- **BAL** — A balanced signal is generated at the XLR connector; the maximum output level is 20 V. The output impedance can be selected in three steps.

Impedance

Selection of output impedance, with BAL selected; the output impedance of the unbalanced output is 5 Ω.

- **10 Ω**
- **200 Ω**
- **600 Ω**

Anlg Freq

Entry of sinewave frequency of analog signal

Specified range:2 Hz to 110 kHz

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Anlg Ampl

Entry of sinewave amplitude of analog signal

Specified range:0 to 10 V_{rms} for UNBAL
0 to 20 V_{rms} for BAL

Units: V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | dBu | dBV | dBm

Peak-to-peak amplitude: $V_{ss} = V_{rms} \times 2 \times \sqrt{2}$

2.5.5.2 Auxiliary Generator Used as Common Mode Generator

The auxiliary generator superimposes a common-mode sinewave signal on the digital output signal.

Note: *This common mode signal can also be generated by the function generator in the source mode COMMON ONLY. Signal shapes other than sinusoidal are possible for the noise signal (e.g. noise), but the audio data cannot be set.*

Comm Freq

Entry of common mode frequency

Specified range:2 Hz to 110 kHz

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

Comm Ampl

Entry of common mode amplitude

Specified range:0 to 7.071 V_{rms}

Units: V | mV | µV | V_{pp} | mV_{pp} | μV_{pp} | dBu | dBV | dBm

Peak-to-peak amplitude: $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$

2.5.5.3 Auxiliary Generator Used as Jitter Generator

The auxiliary generator superimposes a sinewave jitter signal on the digital output signal.

Note: *This jitter signal can also be generated by the function generator in the source mode JITTER ONLY. Signal shapes other than sinusoidal are also possible for the jitter signal (e.g. noise), but the audio data cannot be set.*

Jitt Freq

Entry of jitter frequency

Specified range:2 Hz to 110 kHz

Units: Hz | kHz | ΔHz | ΔkHz | f/fr | Δ%Hz | Toct | Oct | Dec

JittPkAmpl

Entry of jitter peak amplitude

Specified range:0 to 0,25 UI

Units: UI | %UI | dBUI | ppm | ns

Note: *For all applications for which the jitter peak amplitude of the auxiliary generator is not sufficient, the jitter signal can also be generated by the function generator in the source mode JITTER ONLY. Setting audio data is not possible in this case.*

2.5.5.4 Auxiliary Generator Sweep

The sweep system of the auxiliary generator is similar to that of the function generator (see 2.5.4.2 Sweeps). A 2-dimensional sweep, i.e. simultaneous sweep of frequency and level, is not implemented.

SWEEP CTRL see 2.5.4.2 Sweeps

FREQ FILE Entry of a file name for the frequency list (list sweep).
For entering file names see 2.3.2 Data Entry

VOLT FILE Entry of a file name for the amplitude list (list sweep).
For entering file names see 2.3.2 Data Entry

2.6 Analyzers (ANALYZER Panel)

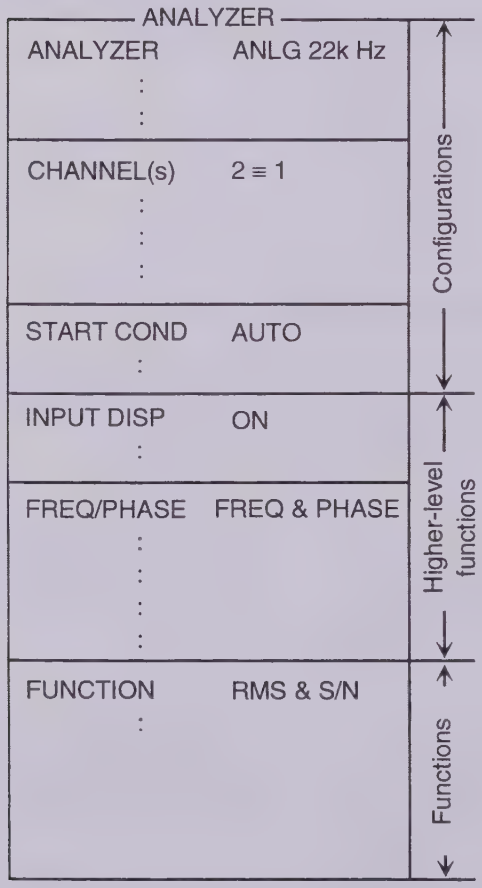
Activate the ANALYZER panel:
UPL front panel: ANLR key
External keyboard: ALT + A
Mouse: (repeated) click on the panel name, until the ANALYZER panel is displayed

If the ANALYZER panel is already visible on the screen, it can be activated also by actuating one of the TAB keys (repeatedly) or by mouse-click.
Advantage: The panel need not be established again.

2.6.1 Selecting the Analyzer

The ANALYZER panel makes the settings for 2 analog and 1 digital analyzer instrument available.

The ANALYZER panel consists of the following segments:



Selection of the analog or digital instrument, reference impedance for power units, configuration segment for setting the test inputs.

(Input connectors, channel selection, input impedance)
see 2.6.3 Configuration of the Digital Analyzer
see 2.6.2 Configuration of the Analog Analyzers

Ways of starting the analyzer, see 2.6.4

Input signal, see 2.6.5.18 INPUT

Combined frequency / phase measurement, see 2.6.5.19

Analyzer functions, see 2.6.5.2 to 2.6.5.19

When switching from the analyzer instrument to the other, the data of all segments are stored for the current instrument, the data of the new instrument are loaded and the panel contents can be entered anew. When changing to the analyzer function, the settings in the configuration range are retained.

Note: *The "parameter link" function which can be selected in the OPTION panel may be used to influence the UPL with changes of function and instrument. As requested, existing settings in the function and/or configuration segment of the GENERATOR panel are accepted for the new function or instrument - if physically possible.*

Measurement range limits of the ANALYZER instruments:

Table 2-27

Instrument	Lower limit	Upper limit	Sample rate
ANLG 22 kHz[1)]	DC/10 Hz	21.9 kHz	48 kHz
ANLG 110 kHz[1)]	DC/20 Hz	110 kHz	307.2 kHz
DIGITAL	DC 10 Hz	2)	27 to 55 kHz

1) The frequency value refers to the upper limit of the analog analyzers

2) The frequency value refers to the upper limit of the sampling rate of the digital analyzers, limit depends on sampling rate

Lower limit:

DC: Setting the DC function in one of the two analog analyzer instruments results in DC coupling of the input unit

10 Hz: The menu item "Min Freq" in the analyzer instruments ANLG 22 kHz and DIGITAL indicates the lower limit.

20 Hz: The menu item "Min Freq" in the "fast" analyzer instruments (ANLG 110 kHz) indicates the lower limit.

Upper limit:

Signals can be measured up to this limit.

Measurement range limits of the digital ANALYZER instrument:

The maximum measurement frequency is given by

f_{max} = *sample frequency x 0.5 for RMS, otherwise sample frequency x 117 / 256*

Set the sample frequency in the configuration segment of the ANALYZER panel using menu item Sample-Frq.

For more details, refer to 2.6.3 Configuration of the Digital Analyzer.

Table 2-28 Availability of functions depending on the ANALYZER instrument:

Instrument	Measurement functions																
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD +N	MOD DIST	DFD	Wow &FL	FFT	Cohe r	Rub & Buzz	Polarity	Filter simul.	1/3-Octave	WAVE-FORM
ANLG 22 kHz	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
ANLG 110 kHz	yes	yes	-	-	yes	yes	yes	yes	yes	-	yes	-	yes	yes	yes	-	yes
DIGITAL	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	-	yes	yes	yes	yes

Higher-level functions:

The selected function can be complemented by higher-level supplementary functions.

INPUT-DISP measurement:

see 2.6.5.18

- PEAK Display of the peak value of the two input signals
- RMS Display of the rms value for the measurement functions THD, THD+N, FFT, MOD DIST and DFD
- PHAS TO REF (with Jitter option UPL-B22 only in the analyzer mode JITTER/PHAS)
  Display of phase between selected digital input and reference input
- DIG INP AMP (with Jitter option UPL-B22 only in the analyzer mode COMMON/INP)
  Display digital signal amplitude

If INPUT DISP RMS is set and a measurement function is selected which does not allow for RMS display or where it does not make sense, "-----" is displayed in the Input RMS window. INPUT PEAK measurements can still be performed.
The availability of the INPUT RMS measurement related to the selected measurement function can be looked up in the subsequent table.

Frequency and phase measurement

see 2.6.5.19

- FREQuency display on all channels switched on

Additionally, in the analyzers ANLG 22 kHz and DIGITAL

- FREQuency display on channel 1, PHASE display on channel 2; selectable only with two-channel measurement
- FREQuency display on channel 1, GRPDEL group delay) display on channel 2, selectable only with two-channel measurement

Additionally, in the analyzer DIGITAL

- SAMPLE FREQuency display on all channels switched on

If a measurement function has been selected which does not allow frequency or phase measurement or where it does not make sense (such as DFD), "-----" is displayed in the "Freq & Phase" window. Refer to the table below for the availability of the frequency and phase measurement in dependence of the selected measurement function.

Table 2-29 Availability of frequency and phase measurement depending on measurement functions

Measurement function	INPUT DISP		FREQ/PHASE		
	PEAK	RMS	FREQ	PHASE	GRP DELAY
OFF	yes	yes	yes	ANLG 22kHz/DIGITAL	ANLG 22kHz/DIGITAL
RMS & S/N	yes	ANLG 110 kHz	yes	ANLG 22kHz/DIGITAL	ANLG 22kHz/DIGITAL
RMS select	yes	yes	yes	no	no
PEAK & S/N	yes	no	no	no	no
Q PK & S/N	yes	no	no	no	no
DC	yes	no	no	no	no
THD	yes	yes	yes	no	no
THD+N	yes	yes	yes	ANLG 22kHz/DIGITAL	ANLG 22kHz/DIGITAL
MOD DIST	yes	yes	no [1)]	no	no
DFD	yes	yes	no[1)]	no	no
WOW & FL	yes	no	no	no	no
POLARITY	yes	no	no	no	no
FFT	yes	yes	yes	ANLG 22kHz/DIGITAL	ANLG 22kHz/DIGITAL
FILTSIM	no	no	no	no	no
WAVEFORM	yes	no	no	no	no
Coherence	yes	no	no	no	no
1/3-OCTAVE	yes	no	no	no	no
Rub & Buzz	yes	ANLG 110 kHz	yes	no	no

[1)] However, the individual frequencies of signal and interference are displayed in a histogram or spectrum list.

2.6.2 Configuration of Analog Analyzers

The two-channel analog analyzer features balanced XLR test inputs; unbalanced BNC cables can be connected via an *adapter* plug UPL-Z1 which can be supplied separately. Both channels can be configured individually. The configuration is explained by way of the below ANALYZER panel and its menu items.

Min Freq

Display of the lower frequency range limit.

10 Hz

lower limit frequency 10 Hz with ANLG 22 kHz

20 Hz

lower limit frequency 20 Hz with ANLG 110 kHz

Ref Imped

(Reference Impedance)

Reference impedance as reference for computing the units dBm, W, Δ%W, ΔW, P/Pr and %P/Pr (see 2.4 Units).

Specified range: 1 mΩ to 100 kΩ

Channel(s)

Select the input channels.

1
2

The selected channel only is active, the other one is switched off.
The input impedance is retained at the XLR female connectors when the channel is switched off (see "Input" BAL XLR, "Impedance").

1 & 2

Both channels are active and can be configured individually.

2 ≡ 1

Both channels are active and equally configured. When *switching over* to this selection causes channel 2 to be set using the parameters of channel 1.

1 ≡ 2

Both channels are active and equally configured. When *switching over* to this selection causes channel 1 to be set using the parameters of channel 2.

Coupling

Selection of input coupling.
AC or DC coupling may be selected to make use of the full frequency range of the UPL (DC to 22/110 kHz) and to suppress the undesired DC of the DUT. This selection can be made (with setting "1&2") independently for both channels.

AC

AC coupling: a DC offset of the DUT will not be transmitted and does not therefore affect the DUT.
The specifications of the UPL analyzer are with reference to this type of coupling.

When the DC measurement function is selected, the setting "AC coupling" is ignored, i.e. the measurement is always performed with DC coupling. The input impedances with 300 Ω and 600 Ω are generally DC-coupled (see Impedance).

Note: *A procedure similar to AC coupling can be selected in the digital analyzer for specific measurement functions. Selection is made with menu item "DC Suppress ON" under the specific measurement function.*

DC

DC coupling: test signals up to 0 Hz are picked up and considered in the results of RMS, RMS selective, peak, quasi peak, DC, FFT and waveform measurements.

Note: *Irrespective of the selection made here, "Min Freq" is used as the limit frequency for automatic algorithms (e.g. "Range AUTO", "Meas Time AUTO"). Signals below the specified "Min Freq" can be detected but not reliably interpreted with these automatic functions. In the event that very low-frequency signals are to be measured (with DC coupling), it is recommended to use the settings FIX or VALUE.*

Input

Select the input mode.

The current setting is displayed. (See also 2.12 Display of Selected Inputs / Outputs). The input mode can be reset after having opened the selection window.

BAL

Balanced to ground test inputs via XLR female connectors (see Fig. 2-18). Deactivated inputs are floating, set input impedances 300 Ω or 600 Ω are retained.
Unbalanced measurements can be performed via BNC/XLR *adapter* (UPL-Z1 option).

GEN1
GEN2
GEN CROSSED

Internal connection of the analyzer input or both analyzer inputs to the generator output of the other channel, respectively. Allows the device-internal measurement of the voltages at the generator connectors as well as crosstalk and two-port measurements. The generator output is loaded by each analyzer channel by 2 x 100 kΩ (see Figures 2-17, 2-18 and 2-19). The input connectors (female) of the appertaining analyzer channels are inactive.

Note: *If both channels are configured equally (channels 2≡1 or 1≡2), GEN CROSSED is displayed instead of GEN CH1 or GEN CH2. Physically, this conjunction is identical.*

Impedance

Select the input impedance, only selectable in BAL mode.

300 Ω

Impedance 300 Ω, input impedance is DC-coupled.

600 Ω

Impedance 600 Ω, input impedance is DC-coupled.

200 kΩ

Impedance 200 kΩ

With impedances 300 Ω and 600 Ω, only voltages of up to 25 V may be applied. With voltages > 25 V the input is protected against overloading. The input impedance is temporarily switched to 200 kΩ and the generator output switched off, see **2.13** Fast Switch-off of Outputs. The overload protection of the analyzer inputs is valid for analog board versions ≥ 4.00 and software version ≥ 1.0.

Common

Common reference of potential of the XLR inputs, selectable in the BAL mode only.

FLOAT

XLR pin floating against chassis ground.
Permissible voltage ≤ 30 V AC or 50 V DC against chassis ground.

GROUND

XLR pin 1 connected to frame ground (PE conductor).
Switchover to GEN mode at a later date or switching off the set balanced channel renders the reference to ground ineffective.

Important:

Reference to measurement potential only, no safety connection to VDE 0411!
When connecting a measurement source, a current of 2 A via the device-internal ground connection should not be exceeded, otherwise the device may be damaged.

Note:

When using a BNC/XLR adapter (UPL-Z1), the XLR pins 1 and 3 are connected via the adapter. The FLOT/GROUND switchover then allows selection of the reference of potential of the BNC external conductor.

Range

Select the measurement range.

Allows the optimum voltage range to be set depending on the measurement sphere. After having opened the selection window, 3 modes are offered for selection.

AUTO

Automatic selection of the range.

FIX

The set range is retained in any case.

Note: *When switching from AUTO →FIX, the currently valid channel range is used. In the configuration Channels →2≡1 or 1≡2, the less sensitive of the two ranges of channel 1 and 2 is transferred.*

LOWER

The set range is kept as the lowest range. Overloads cause higher ranges to be automatically switched over to.

After having chosen the FIX and LOWER modes, the rated value set for the range is displayed in the subsequent line where a new range can be set after having opened the selection window.

Table 2-30 Voltage measurement ranges of analog analyzers

Measurement range	Measurement function		Remarks
(Nominal value)	DC	Others	
18 mV	[1]	yes	
30 mV	[1]	yes	
60 mV	[1]	yes	
100 mV	yes	yes	
180 mV	[1]	yes	
300 mV	yes	yes	
600 mV	[1]	yes	
1.0 V	yes	yes	
1.8 V	[1]	yes	
3.0 V	yes	yes	
6.0 V	[1]	yes	
10.0 V	yes	yes	
18.0 V	[1]	yes	
30.0 V	yes	yes	
60.0 V	[1]	yes	Ranges 60.0 V and 100.0 V are available for analog board versions ≥ 4.00 and software versions ≥ 1.0.
100.0V	yes	yes	

[1] With the DC function, the next insensitive and valid range is internally set when selecting the range. (see 2.6.5.5 DC)

An optimum dynamic range for the measurement of non-linear distortions is guaranteed by spacing the range in 5-dB steps. Overranges or underranges in the current measurement range causes the switchover to the next possible range provided that RANGE AUTO is selected. The same is true for RANGE LOWER, however switchover to the next lower range is performed only when the range limit selected in the menu is not violated.

The range values are rms values for sine or other waveforms with a crest factor of $\sqrt{2}$ or less.

Equivalent circuit diagrams of test inputs:

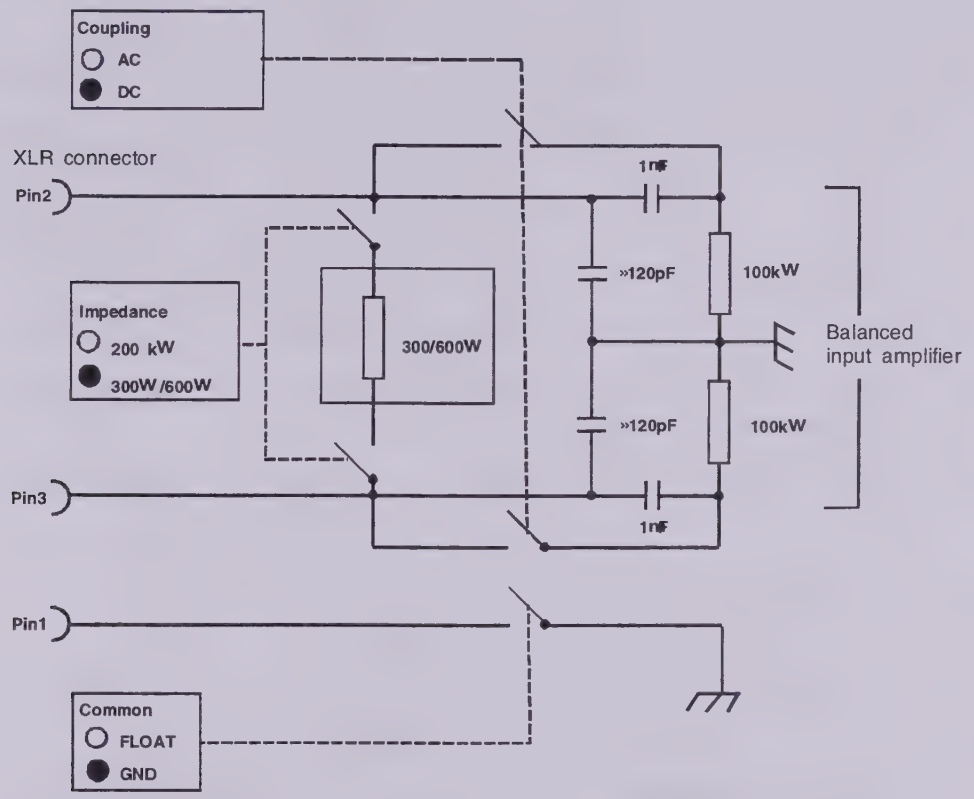


Fig. 2-16 Balanced input (Input BAL, channel 1 or 2)

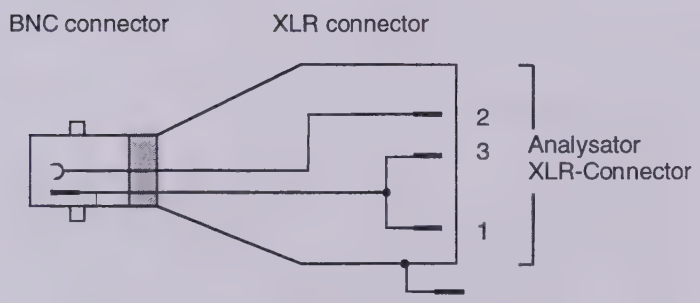


Fig. 2-17 Unbalanced measurement via BNC/XLR adapter

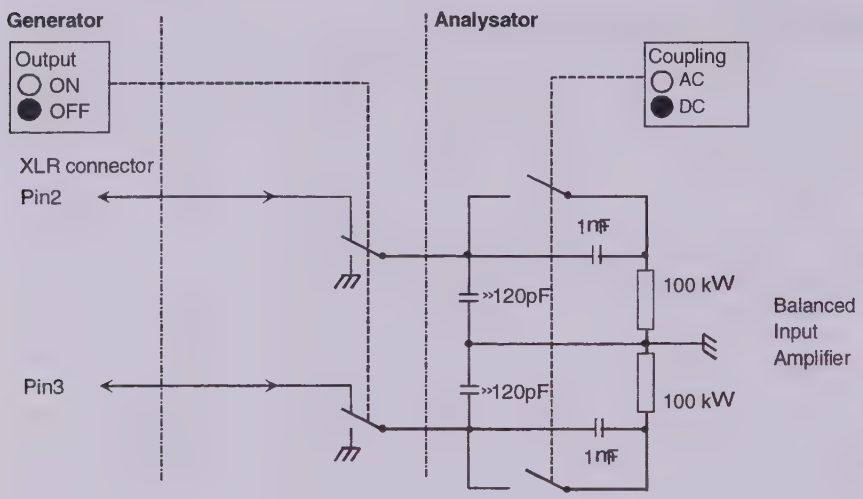


Fig. 2-18 Internal connection to generator output

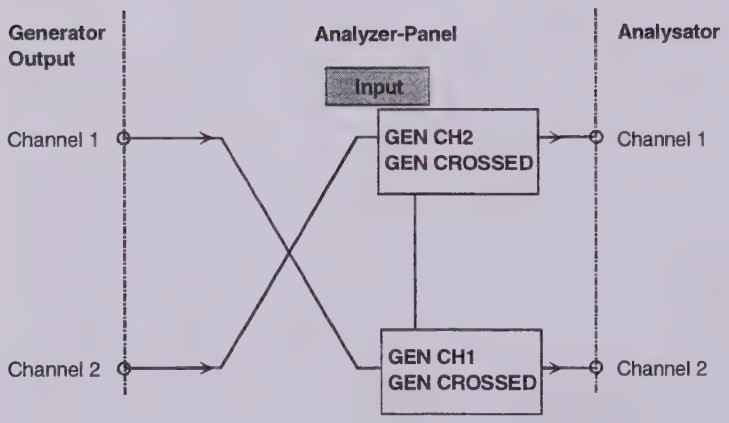


Fig. 2-19 Internal signal paths

2.6.3 Configuration of Digital Analyzer

Notes:

- *Prior to making the analyzer settings, the generator should be configured usefully. Otherwise, undesired generator settings could cause superfluous restrictions in the analyzer panel.*
- *If the generator is not used as a signal source, it is advisable to switch over to analog mode in order to avoid any interference of the generator settings.*

Meas Mode (measurement mode)

indicates what is to be measured at the digital interfaces.

AUDIO DATA Measurement of digital audio data

JITTER/PHAS Measurement of jitter at the selected digital audio input and of the phase offset to the reference signal (REF IN at the rear of the instrument).

COMMON/INP Measurement of COMMON signal (at XLR female connector) and digital input amplitude.

Note: *A COMMON measurement is not possible at the unbalanced digital input (BNC connector). Therefore, irrespective of the selected input, the COMMON MODE measurement is always performed at the balanced input (CLR connector). Consequently, selection of the digital input only affects the measurements of DIG INP AMP and SAMPLE FREQ.*

Note: *Functions producing a level measurement result are the only appropriate with Jitter/Phas Common/Inp modes which is why function selection is restricted to the level measurements (RMS and PEAK) as well as the FFT and waveform display. With FFT selected, RMS values are displayed.*

Min Freq

Is displayed only if AUDIO DATA has been selected as Meas Mode.

10 Hz Display of the lower frequency range limit for measurement of the digital audio data.

Channel(s)

Is displayed only if AUDIO DATA has been selected for Meas Mode.
All other analyzer modes refer to the digital data *stream* and not to the data *content* so that specifying a channel would be meaningless.

1 Measurement on channel 1, only; data of channel 2 are ignored.

2 Measurement on channel 2, only; data of channel 1 are ignored.

BOTH Measurement on both channels

Input

Selection of input interface:

BAL XLR

Balanced digital input (XLR)

UNBAL BNC

Unbalanced digital input (BNC)

Note: *In the measurement mode COMMON/INP (with Jitter option UPL-B22 only) a warning is displayed that a COMMON measurement is not possible at the unbalanced digital input. The measurement of the COMMON MODE signal is always performed at the BAL XLR connector, irrespective of the selected digital input. Only the DIG INP AMP and SAMPLE FREQ measurements are carried out at the UNBAL BNC connector.*

OPTICAL

Optical digital input (TOSLINK)

INTERN

Digital input for test and demonstration purposes

Jitter Ref

(Jitter Reference)

Is displayed only, if JITTER/PHASE has been selected for Meas Mode. Indicates the signal to which the jitter measurement is referred.

Note: *The phase measurement is always referred to the REF input.*

VARI (PLL)

The sample signal derived from the input signal via the internal synchronization PLL is used as reference signal. Synchronization is made via the VCO with maximum lock-in range (sample frequency 27 kHz to 55 kHz).
Not possible if the source mode JITTER/PHASE has been selected in the generator, since the internal PLL is already required for phase generation in this mode.

32.0 (PLL)
44.1 (PLL)
48.0 (PLL)

The sample signal derived from the input signal via the internal synchronization PLL is used as reference signal. Synchronization is made via the fixed-frequency VCXO.
Not possible if the source mode JITTER/PHASE has been selected in the generator, since the internal PLL is already required for phase generation in this mode.

Note: *Synchronization to the input signal by means of the internal PLL should be selected only, if the jitter signal is generated by an external device.*

GEN CLK

The generator clock serves as reference signal.
Possible *only,* if the generator is also synchronized to the internal generator clock (menu item Sync To GEN CLK in the GENERATOR panel)

Note: *GEN CLK is only meaningful, if the jitter signal is generated by an own generator.*

Sync To

(Analyzer synchronized to)

Is displayed only, if AUDIO DATA has been selected for Meas Mode; with JITTER/PHASE, *fixed settings* are obtained (depending on "Jitter Ref" and the synchronization of the generator).
Indicates the input signal to which the analyzer is synchronized.

AUDIO IN — Synchronization to the digital AUDIO input signal (front panel).

REF IN — Synchronization to the REF IN input signal (XLR female on the rear panel).

Note: *In Meas Mode JITTER/PHAS the analyzer automatically synchronizes to the clock selected as "Jitter Ref"*

Sample Freq

Is displayed only if AUDIO DATA has been selected as Meas Mode.

Setting the signal clock rate.
The clock rate can be selected as desired only, if the analyzer does not synchronize to the generator clock, otherwise - if in the JITTER/PHAS Meas Mode the generator has been selected as Jitter Ref - Sample Freq is automatically set (invisible to the user) to the generator clock rate.

32 kHz
44.1 kHz
48 kHz
VALUE:

The analyzer is informed on the sample frequency *applied* by means of the (numerical or predefined) selection of the sample frequency in order to enable correct measurement of the audio signal frequencies. This information does not influence the synchronization of the analyzer.
Specified range for VALUE: 27 Hz to 55 kHz.

AUTO — The measured sample rate is automatically stored as Sample Freq. The sample rate is updated once a second if the value varies by more than 0.01%.

CHAN STATUS — For determining the sample rate the corresponding channel status bits in the AES/IBU protocol of the test signal are decoded. Depending on the format (consumer or professional) different bits are interpreted (24 to 27 or 6 to 7). The sample rate is updated as soon as a different sample rate is indicated by the channel status bits.
If the channel status bits do not yield any information ("not indicated") or if the protocol analysis is switched off, the sample rate set last remains but it can be modified by the user.

Note: *If the frequency entered does not correspond to the frequency applied, all filter and frequency measurements vary accordingly in frequency! The frequency applied to the UPL (sample rate) must not exceed* ***55 kHz****, since, otherwise, incorrect measurements or abortion of the measurement may occur. If the digital generator is operated simultaneously at a frequency of more than 48 kHz, the limit frequency for correct operation is reduced to 53 kHz.*

The maximum measurement frequency of the digital analyzer is obtained from the sample frequency and the (modified) "Nyquist" factor:

$$f_{max} = \text{sample rate} \times 117 / 256$$

Audio Bits

8 to 24
Reducing the word length causes the audio sample values to be cut to the specified word length.

2.6.3.1 Measurement of Jitter, Phase and Common Mode

With digital audio interfaces, there are two types of signals to be measured, e.g., within a quality check. One is the digitally coded analog signal, and the other the digital signal. The latter toohas analog parameters such as peak-to-peak voltage, frequency etc. It may be subject to interference like an analog signal. Noise or AC voltage may be superimposed, which may cause the signal slopes to be shifted. This effect is called jitter and, if it is strong enough, the audio signal can no longer be decoded or regenerated correctly. The conventional decoders fail often even before reaching the theoretical limit which is why information on the practically reached jitter in a facility is quite important.

The signal lines can be designed as balanced lines which is quite usual in analog technology. Thus, injected interferences, e.g. from grounded (hum) loops would be ineffective. However, in practice, this attenuation is not always sufficient so that a common-mode voltage of sufficiently high magnitude may also prevent decoding and regeneration. The UPL can measure this common-mode voltage on the digital signal. Of course, a common-mode signal cannot be generated at the unbalanced and the optical output.

The UPL can thus measure two different types of interference of the digital audio signals: shifting of the signal slopes (jitter) and a common-mode voltage superimposed on the digital lines. The analog generator is available for measurement of the interference voltages. The RMS (&S/N) and peak functions as well as the FFT analysis and the oscilloscope display (WAVEFORM) are particularly suited for the practice. The spectrum analysis allows first conclusions to be made on the cause of the interference (e.g., superimposed AC hum or switching power supply). The interference caused by the common-mode voltage can be read off directly as voltage.

Jitter and delay are usually stated in UI (unit interval). UI is defined as the smallest pulse width of the digital audio signal (eye width) and is independent of the selected sample frequency. One UI corresponds to the clock period of the digital signal (biphase clock). With digital audio signals, one UI corresponds to the 128th of the sample period; at 48 kHz one UI is approx. 163 ns.

For measuring the jitter, a reference clock must be available. For this purpose a high-stability internal oscillator can be used or a PLL (phase locked loop), if the UPL is externally synchronized (via the "Sync In" connector on the rear panel). The PLL integrates phase deviations as a function of time. Both the internal oscillator and the PLL are also used for the digital generator, so that analyzer and generator cannot be set completely independent of each other in this case.

If several, digitally-coded signals have to be interconnected, as commonly done in the studio, the signal synchronization is also of importance. Associated frames, which contain the respective instantaneous values (samples) of the left and right channels, must not be delayed such that the timing tolerances of the receiver are exceeded. This can be noticed as omission or doubling of individual samples. The UPL can measure this shift as phase between the digital input on the front panel and the reference channel ('Ref In' connector on the rear panel).

In addition to the method described above which uses an external clock frequency (Sync PLL), the analyzer as a decoder and measuring instrument for the data contents itself (i.e. not as a jitter/phase meter or common-mode analyzer) can also be synchronized directly to the digital signal at the analyzer input via the menu item "Sync To". A difference has to be made between the input on the front panel (AUDIO IN) and the input of the reference receiver (REF IN) on the rear panel. Moreover, the analyzer can be synchronized also to the internal digital generator (GEN CLK).

2.6.4 Ways of Starting the Analyzer, Ext. Sweep

Available for

all three ANALYZER instruments. No external sweeps are however possible in ANLG 110 kHz, i.e. in addition to the AUTO measurement mode only the time-triggered measurements (TIME TICK and TIME CHART) can be selected.

Theory of operation

"START COND" determines when, how often or the conditions which must prevail to trace measured values.

Depending on the selection of START COND, the measured value is - when the conditions required for tracing of measured values are met - triggered, displayed in a UPL trace buffer. The trace buffer may contain up to 17 K (17408) measurement data depending on the application.

The measured value list can be displayed or represented in the form of graphics (see 2.10). If the options UPL-B10 or UPL-B4 are fitted, it can also be read in via a self-controlled program or external controller.
Depending on the selection of START COND, the measurement either starts immediately (AUTO) or only when the desired trigger condition is fulfilled.
With START COND not AUTO, an external sweep (START COND → FREQ CH1/2, FRQ FST CH1/2, VOLT CH1/2) or periodic measured value tracing (START COND → TIME TICK, TIME CHART) or armed single (START COND → LEV TRG CH1/2) is started using the START or SINGLE keys (see 2.11 Starting and Stopping of Measurements or Sweeps).

START COND (Start Condition) specifies an event triggering off a measurement.

AUTO Continuous measurement mode without trigger condition. The measured values are stored in the trace buffer only, if the frequency sweep of the selective RMS measurement or any generator sweep is active, simultaneously.
The SINGLE or START keys allow you to switch between single and continuous measurement when no sweep is active.
The AUTO mode must be activated to enable the sweep of the frequency of the selective rms measurement (see 2.6.5.3 RMS SELECT) or of the generator parameters (see 2.5.4.2). Several sweeps at the same time are not permissible and can therefore not be set.

START COND

The measured values are triggered at regular intervals. The intervals for starting measurements are determined by the distance between the timeticks. The measured values are entered in the buffer and displayed in the measurement result window.

TIME TICK

The START key is used to start a sequence of periodic tracings of measured values, which is restarted from the beginning when the number of sweep points specified under "Points" is reached.
If the timetick is greater than the measuring time, the next timetick is waited for after each single measurement; no measurement is performed during this period.
If the timetick is smaller than the measuring time, the next timetick is only triggered after completion of the measurement. The sweep is then indicated with corrected x-axis, i. e. the single measured values are entered with correct timing.
The SINGLE key allows you to start a single sequence of periodic tracings of measured values. The sweep enters the SWP TERMINATED state when the number of sweep points specified under "Points" is reached. The analyzer state is then "TERMINATED".

TIME cannot be simultaneously active with the frequency sweep of the selective rms measurement or any generator sweep!

TIME CHART

Measured values (of the running continuous measurement) are entered in a time chart in the time pattern that can be entered under "Time". Contrary to TIME TICK, where a new (single) measurement is started with each tick and the result is only entered after completion of the measurement, TIME CHART also permits to display intermediate results. This is useful in particular in the case of quasi-peak measurements.

FREQ CH1
FREQ CH2
FRQ FST CH1
FRQ FST CH

Tracing of measured values because a change in frequency was noted at ANALYZER input channel 1 or channel 2.
With the START or SINGLE key, an external frequency sweep is started, which in turn starts a single measurement on the occurrence of a trigger event or, as the case may be, after a delay to be entered. The measurement result is entered in the measured value buffer.
Starting a continuous sweep using the START key causes the sweep to be restarted after any change in frequency in the direction from stop to start frequency (see 2.11).
A single sweep started by the SINGLE key is stopped by a measured value beyond the stop frequency.
Changes of the frequency of STOP and START are ignored.

Note: *FRQ FST CH1/2 can be selected for especially fast frequency sweeps with clean signals (e.g. from the CD). If however the signal has a large noise component, the slower measurement procedure FREQ CH1/2 must be used.*

FREQ CH1|FREQ CH2-|FRQ FST CH1|FRQ FST CH2 cannot be simultaneously active with the frequency sweep in the RMS Select measurement or any generator sweep!

Note: *By activating the associated* ***settling,*** *unwanted interfering signals like voice can be made ineffective. It must be switched off with floating sweep.*

START COND

VOLT CH1
VOLT CH2

A measurement result is recorded because a voltage change is detected at the analyzer input channel 1 or 2.
With the START or SINGLE key an external voltage sweep is started, which in turn starts a single measurement upon a trigger event (or after a delay to be entered). The measurement result is stored in the buffer.
When a continuous sweep is started with the START key, the sweep is restarted every time the voltage changes in the direction from the stop to the start level.
If a single sweep is started with the SINGLE key, the sweep is stopped by a measured value beyond the stop level. Changes of the STOP and START voltages are ignored.

VOLT CH1 | VOLT CH2 cannot be simultaneously active with the frequency sweep of the selective RMS measurement or with any generator sweep.

Note: *In most cases (e.g. sliding sweep) it is advisable to perform an external voltage sweep with Settling switched on to prevent individual test points to be triggered too early by voltage transients. Two samples are sufficient for the settling parameters; the resolution should be set to minimum.*

LEV TRG CH1
LEV TRG CH2

Triggering (single shot) because of a *level* detected at analyzer input channel 1 or 2. Measured values are not stored in the trace buffers and, consequently, there is no graphical display via the X axis.
Using the START or SINGLE key, level monitoring is enabled. It waits for the level to enter the range between Start and Stop for the first time. Then a single measurement is started - possibly after the entered delay.
If the continuous trigger has been started with the START key, new triggering in the specified range takes place only if the level had been out of this range at the upper or lower end. Hence, level monitoring is only reactivated when a level is detected outside the specified range.

EDG TRG CH1
EDG TRG CH2

Triggering (single shot) caused by a voltage *edge* detected at the analyzer input channel 1 and 2. The measured value is neither stored in the buffers nor graphically displayed via the X axis.
Level monitoring is started with the START or SINGLE key but it is only activated when a level outside the start-stop interval is measured. Triggering is performed when a level occurs for the first time in the range between Start and Stop (edge trigger). A single measurement is then started - possibly after the specified delay.
If continuous trigger has been started using the START key, new triggering in the specified range only takes place when the level had been out of the range at the upper or lower end. Hence, level monitoring is only reactivated when a level is detected outside the specified range.

By pressing the STOP key, an external sweep is finished. By pressing the CONT key, the continuous measurement mode is started again.

Delay

The menu items START COND →

AUTO | FREQ CH1 | FREQ CH2
FRQ FST CH1 | FRQ FST CH2
VOLT CH1 | VOLT CH2
LEV TRG CH1 | LEV TRG CH2
EDG TRG CH1 | EDG TRG CH2

allows the user to enter a delay time, which is useful for:

- Signal modifications at the generator (entry of values, variations via rotary knob)
- Sweeps
- Actuation of STOP/CONT or START keys (continuous measurement)
- SINGLE key actuation (single measurement)
- Modifications in the ANALYZER panel
- Modifications in the GENERATOR panel
- Modifications in the FILTER panel

Delay determines the waiting time required from the events stated above to the restart of a measurement in order to allow the device under test to settle.

Specified range:50 ms to 10 s

Units: s | ms | µs | min

Note: *Delay is considered in single measurements only, i.e. in single measurements triggered by the SINGLE key or sweep sequencing in the START COND → AUTO mode or on the occurrence of a trigger event in the START COND → FREQ CH1/2, VOLT CH1/2 modes.*
During continuous measurements, delay is considered in the first measurement only. The following measurements are made without delay.

Time

In the menu item START COND → TIME TICK| TIME CHART the intervals between the single tracings of measured values can be specified.

A single measurement is started after every time **tick**. A new measurement is only triggered when the last measurement has been completed. If a time tick is selected which is smaller than the measuring time, the time tick is adapted internally to the measuring time; i.e., it is extended to be identical.

With the start condition TIME ***CHART,*** the current measured value is entered upon expiry of the time entered, independent of the number of measured values obtained in the meantime, if any. If a time is selected which is smaller than the measuring time, the same result is traced several times (with different x-values). If this effect is to be avoided, "Time" must be increased.

Specified range: 10 ms to 2000 s

Units: s | ms | µs | min

Resolution: 1 ms

Points

The menu item START COND → TIME TICK | TIME CHART allows the number of entries in the measured value buffer to be entered.

Specified range: 2 to 1024

Note: *A time-tick scan is terminated after (points x time tick) seconds. If the individual measurements cannot be performed at the selected time-tick rate - due to an exceeded time-tick set - the trace buffer contains less than "points" measured values.*

Min VOLT

The menu items START COND →

FREQ CH1 | FREQ CH2
FRQ FST CH1 | FRQ FST CH2

allow the entry of a minimum voltage to be applied to the ANALYZER input in order to trigger a measurement.

Specified range:
digital (audio data mode): 0.00001 to 1.0 FS
analog: 0.00001 to 30 V

Units:
digital (audio data mode):
FS | %FS | dBFS | LSBs | bits
analog:
V | mV | µV | dBu | dBV | dBm | W | mW | µW

Start

Stop

The menu items START COND →

FREQ CH1 | FREQ CH2
FRQ FST CH1 | FRQ FST CH2
VOLT CH1 | VOLT CH2
LEV TRG CH1 | LEV TRG CH2
EDG TRG CH1 | EDG TRG CH2

allow the entry of the start and stop values. The frequency or level applied to the ANALYZER input must not exceed the start/stop limits in order to trigger the measurement.
By single sweeps, the STOP value is used to recognize the end of the sweep. The STOP value should therefore be somewhat smaller than the expected signal range.

Specified range
- FREQ CH1 | FREQ CH2 FRQ FST CH1 | FRQ FST CH2:
  total range permitted (see 2.6.1)
- VOLT CH1 | VOLT CH2:
  analog: 10 µV to 30 V
  V | mV | µV | dBu | dBV | dBm | W | mW | µW
  digital: LL to 1.0 FS
  FS | %FS | dBFS | LSBs | bits
  LL: The lower limit for the level start/stop values depends on the number of audio bits (see 2.6.3), however must not be less than 1µFS. It can be calculated as follows:
  $LL = 2^{-\text{Audio Bits}}$

Variation

The menu items START COND →

FREQ CH1 | FREQ CH2
FRQ FST CH1 | FRQ FST CH2
VOLT CH1 | VOLT CH2

allow the entry of a value in percent by which the input frequency or input voltage must be varied at least in order to trigger a measurement.
Changing the frequency or voltage in the direction from stop to start by this numeric value causes a restart of the sweep if continuous sweep has been set..

Note: *Select the variation 5 % to 10 % smaller than the expected change in order to guarantee reliable triggering on the one hand and to prevent triggering on intermediate values on the other hand.*

Specified range:LL to 50%
Unit: %

LL: The lower limit for the entry of variation is not less than 0.1% and is output such that not more than 1024 measured values are generated (depending on the spacing between start and stop values).

Settling

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5 Functions

FUNCTION	
	Note: *The addition "&S/N" indicates that this function allows S/N measurements.*
OFF	No measurement function, measurement of Input RMS/PEAK and frequency/phase, however, enabled
RMS & S/N	True RMS measurement of AC voltages see 2.6.5.2
RMS SELECT	Selective RMS measurement with narrow bandpass see 2.6.5.32
PEAK & S/N	Maximum peak value within a monitoring interval, see 2.6.5.4
Q PK & S/N	Peak value detection with subsequent defined rising and falling times, see 2.6.5.4
DC	DC measurement, see 2.6.5.5
THD	Distortion measurement (without consideration of broadband noise), see 2.6.5.6
THD+N/SINAD	Distortion or SINAD measurement (including broadband noise), see 2.6.5.7
MOD DIST	Intermodulation measurement with high-frequency useful sinewave signal and a low-frequency interfering sinewave signal, see 2.6.5.8
DFD	Difference Frequency Distortion measurement by two adjacent tones with relatively high frequencies, see 2.6.5.9
WOW & FL	Wow and flutter measurement see 2.6.5.10
POLARITY	Polarity measurement to check for polarity reversal in a device under test, see 2.6.5.11
FFT	Graphical display of spectrum, see 2.6.5.12
FILTER SIM.	Filter simulation see 2.6.5.13
WAVEFORM	Waveform display; see 2.6.5.14.
PROTOCOL	evaluation and display of AES protocol data Only in the digital analyzer with measurement mode AUDIO DATA.
COHERENCE	Measurement of transfer function and coherence of two signals; with installed option UPL-B6 only, see 2.6.5.22
RUB & BUZZ	Loudspeaker measurements (rub&buzz, frequency response, polarity); with installed option UPL-B6 in the analog analyzers only, see 2.6.5.23
1/3-OCTAVE	1/3-Octave measurement, with installed option UPL-B6 only, see 2.6.5.24

Note: *The addition "&S/N" indicates that this function allows S/N measurements.*

FUNCTION

(*continued*)

DIG INP AMP

Only with Jitter option (UPL-B22). This measurement function is selected under menu item INPUT DISP; see 2.6.5.16.

PHAS TO REF

Only with Jitter option (UPL-B22) This measurement function is selected under menu item INPUT/PHAS; see 2.6.5.17.

2.6.5.1 Common Parameters of Analyzer Functions

DC Suppress

(DC Suppress)

With the **digital** measurement functions RMS & S/N, RMS SEL, FFT and Waveform, a DC component in the test signal can be suppressed so that it is present neither in the measurement result nor in the graphics display. To do so the actual DC value is determined for each measurement and then considered in the measured value by calculation. This preliminary measurement performed for FFT and Waveform requires additional measurement time (approx. 200 ms), but because of the relatively slow measurements this is in most cases not important. With RMS and RMS SEL measurements, the DC component is measured in parallel with the main measurement and does not therefore affect the measurement time.

Note: *This menu item is not offered with* **analog** *measurements, as in this case the function is assumed by the selection of the input coupling (which is superordinate to the functions).*

ON

The DC component of the signal to be measured is suppressed (AC coupling); only the AC component is considered in the measurement result.

OFF

The DC content of the signal to be measured is *not* suppressed (DC coupling) and contained in the measurement result.

S/N Sequ

(S/N sequence)

The functions RMS & S/N, PEAK & S/N, Q-PK & S/N offer the possibility of S/N measurements (signal-to-noise). The generator signal at the device under test is alternately switched on (signal) and off (noise) and a measurement is performed in each case. During signal-on-phase the selected filters are turned off in order to exclusively weight the noise signal. The ratio of the two measured values in dB expresses the S/N ratio of the device under test.
Any desired generator setting is permissible.
A deactivated generator means:

- with analog generator instruments, the output voltage is switched off with the output resistance being constant
- with digital generator instruments, a level value of 0.0 full scale is output with the clock rate being unvaried (all bits to 0)

ON

S/N measurement on

Notes:

- *A filter with high-pass characteristic should be switched on in order to avoid measurement errors due to superimposed dc in the analog range. If this is not the case, a corresponding error message is displayed when switching on S/N mode.*
- *Measurement at low frequencies where a highpass is not usable should be performed using a file defined delay filter with about 1.5 s delay. By this means the DC-level that appears when switching off the generator can decay before noise measurement. is started.*
- *The selectable filters only affect the noise measurement. If they are to affect the signal measurement, too, this can be achieved by using the command line parameter "-o2".*

OFF

S/N measurement off

Measurement function	**selectable analog units:**	**selectable digital units:**
Intermodulation measurements MOD DIST| DFD	%|dB	%|dB
Distortion measurements THD Meas Mode: SELECT di ALL even d ALL odd di ALL di	%|dB	%|dB
Meas Mode: SEL di LEV even di LEV odd di LEV di	VIdBVIdBuIdBmIWIΔ%VI ΔVIV/V_rI%V/V_rIΔ%WIΔ WIP/P_rI%P/P_rIdB	FSI%FSIdBFSIΔ %IdB_rILSBs

Measurement function	selectable analog units:	selectable digital units:
Distortion measurements THD+N Meas Mode: THD+N | NOISE | SINAD	% | dB	% | dB
Meas Mode: LEVEL THDN | LEVEL NOISE	V|dBV|dBu|dBm|W|Δ%V|ΔV|V/V_r|%V/V_r|Δ%W|ΔW|P/P_r|%P/P_r|dB	FS|%FS|dBFS|Δ%|dB$_r$|LSBs
Wow and flutter measurements WOF&FL	%	%
Transfer function (COHERENCE Trace A, Ch1/Ch2)	% | dB	% | dB
Coherence measurement (COHERENCE Trace B)	γ^2	γ^2

Unit Ch1

Selection of the units of measurement results for channel 1.

Unit Ch2

Selection of units of measurement results for channel 2.

With all level measurements, the (display) units for the two channels can be selected independent of each other, e.g., in order to constitute one channel as absolute quantity and the other channel with any reference.

Selectable analog units (also valid for Meas Mode COMMON/INP in DIGITAL instrument):

V | dBV | dBu | dBm | W | Δ%V | ΔV | V/V_r | %V/V_r | Δ%W | ΔW | P/P_r | %P/P_r | dB $_r$

Selectable digital units (Meas Mode AUDIO DATA):

FS | %FS | dBFS | Δ% | dB$_r$ | LSBs | bits

The measurement functions PEAK and QPEAK as well as the INPUT DISP displays also allow the selection of the HEX unit.

Selectable jitter units (Meas Mode JITTER/PHAS):

UI | %UI | dBUI | ppm | ns | UI$_r$ | dB$_r$ (for jitter)

UI | %FRM | ºFRM | ns (for phase)

For conversion formulae and notation of the measured value display units for IEC bus control, see 2.4 Units

Unit

Selection of units for measurement results for both channels. Measurements which usually have both channels with the same unit, provide a common menu item for both channels for selection of the (display) unit.
Basis of calculation see relevant measurement function.
Conversion formulas see 2.4 Units.

Reference

Reference values for the analyzer measurement function and the Input Disp measurement.

All measurements which obtain dimensional results, can be displayed either absolutely or referred to a reference. If a reference-related unit (to be recognized by the addition "r" or the prefix "Δ") is selected, the displayed result takes into consideration the reference entered here.
Each measurement function and each of the superior functions provide their own reference, which applies for both channels, respectively.
The selection made here is entered into the display panel per default, if an appropriate trace (FUNC CH1/2 or IMP RMS CH1/2) and the selected display reference is *not* FILE, HOLD or OTHER TRACE.

Value

Display and entry of a fixed reference value.
Per default, this entry is entered into the display panel if an appropriate trace (FUNC CH1/2 or IMP RMS CH1/2) has been selected and the display reference has been set to VALUE.
The specified range depends on the measurement function and the instrument function (analog or digital):

Units:

digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr
analog and digital common mode:
V | mV | µV | dBu | dBV | dBm | W | mW | µW

Specified range for

- DC measurement function:
  - digital (audio data mode): -100 to 100 FS
  - analog: -1000 to 1000 V
- other (level) measurement functions and INPUT DISP:
  - digital (audio data mode): 100 pFS to 100 FS
  - digital (jitter mode): 100 pUI to 100 UI
  - analog (and common mode): 100 pV to 1000 V

STORE CH1
STORE CH2

The level measurement result of channel 1 or channel 2 is stored on pressing the ENTER key and displayed as new reference value. The reference value does not change during the measurement. These selection items are displayed with two-channel measurement, only.

STORE

The result of a one-channel measurement is stored on pressing the ENTER key. The reference value does not change during the measurement. This selection item is displayed with one-channel measurement.

Reference

MEAS CH1
MEAS CH2

Each level measurement result of channel 1 or channel 2 is immediately stored as the reference value and can then be used (by both channels) for a referenced display. A referenced unit must be selected in this case. These selection items are only available with 2-channel measurements.

DIG OUT AMP

Only for the display of the digital input amplitude (INPUT DISP: DIG INP AMP). The measured value is referenced to the digital signal level set in the digital generator (see 2.6.5.18, INPUT).

GEN TRACK

The current generator voltage and each newly set voltage *of the function generator* are stored as the reference value and can then be used (by both channels) for a referenced display. A referenced unit must be selected in this case.

***Exception**: When the jitter is measured in the digital analyzer, the generator of the jitter signal is used as a reference. So, if the audio data come from the function generator and the jitter signal from the auxiliary generator, the jitter amplitude of the auxiliary generator is used as a reference.*

If the measured value is RMS-weighted, the RMS value of the generator voltage is used. If it is a peak value (INPUT DISP PEAK, PEAK function), the peak value of the generator voltage is used.

If the instrument functions of generator and analyzer are different (analog or digital), a ***conversion factor*** of

$$\frac{1\ \text{FS}}{1\ \text{V}}$$

is calculated.

***Note:** The generator voltage selected in the panel is always used as reference instead of the actually output generator voltage. This applies, in particular, if equalization is switched on (cf. 2.5.4.3 SINE). If reference is to be made to the actually output voltage, the latter must be measured (internally) (CH1 Input GEN CH2) and the measurement result (of channel 2) must be referred to the measured voltage (Reference MEAS CH1).*

Ref Freq

Reference Frequency
Reference value for the frequency measurement.
Results of frequency measurements can be displayed either absolutely or referred to a reference. If a reference-related unit (to be recognized by the addition "r" or the prefix "Δ") is selected, the displayed result takes into consideration the reference entered here; it applies for both channels or (with combined frequency/phase measurement or frequency/group-delay measurement) for the frequency of channel 1.
The selection made here is entered into the display panel per default, if an appropriate trace (FREQ CH1/2) and the selected display reference is *not* FILE, HOLD or OTHER TRACE.

Value

Display and entry of a fixed reference value.
Per default, this entry is entered into the display panel if an appropriate trace (FREQ CH1/2) has been selected and the display reference is set to VALUE.

Specified range: 1 mHz to 1 MHz
Units: Hz I kHz

STORE CH1
STORE CH2

The frequency measurement result of channel 1 and/or channel 2 is stored on pressing the ENTER key and displayed as new reference value. The reference value does not change during the measurement. This selection is provided with two-channel measurement, only.

STORE

The result of a one-channel frequency measurement or a combined FREQ&PHASE measurement or FREQ&GRPDEL measurement is stored on pressing the ENTER key. The reference value does not change during the measurement. This selection is provided with one-channel measurement, only.

MEAS CH1
MEAS CH2

Each frequency measurement result of channel 1 or channel 2 is immediately stored as the reference value and can then be used (by both channels) for a referenced display. A referenced unit must be selected in this case. *Not* available for 1-channel or combined frequency-phase measurements or frequency/group delay measurements.

GEN TRACK

The presently valid generator frequency and each newly set generator frequency are stored as the reference value and can then be used (by both channels) for a referenced display. A referenced unit must be selected in this case.

Note: *The generator voltage selected in the panel is always used as reference instead of the actually output generator voltage. This applies, in particular, if equalization is switched on (cf. 2.5.4.3 SINE). If reference is to be made to the actually output voltage, the latter must be measured (internally) (CH1 Input GEN CH2) and the measurement result (of channel 2) must be referred to the measured voltage (Reference MEAS CH1).*

Ref Phase

(Reference Phase)
Reference value for the phase measurement.
This menu line is displayed only, if two-channel measurement and the phase or group-delay measurement have been selected.
Results of phase and group-delay measurement can be displayed either absolutely or referred to a reference. If a reference-related unit (to be recognized by the prefix "Δ") the result is displayed taking into consideration the reference entered here.

VALUE

Display and entry of a fixed reference value.
Per default, this entry is entered into the display panel if an appropriate trace (FREQ CH1/2) has been selected and the display reference is set to VALUE.

Specified range and units for:

- phase measurement:
  Specified range: - 360° to +360° or -2π to +2π
  Units: ° | RAD
- group-delay measurement:
  Specified range: - 10 s to +10 s
  Units: s | ms | µs | min.

STORE

The results of phase or group-delay measurement are stored on depression of the ENTER key and displayed as new reference value. The reference value does not change during the measurement.

FILTER

For the functions in the ANALYZER panel

- RMS & S/N (RMS measurement), 3 filters
- PEAK & S/N (peak measurement), 3 filters
- QPK & S/N (quasi-peak measurement), 3 filters
- THD+N/SINAD (distortion measurement) 1 filter
- RMSSEL (selective RMS measurement) 1 filter
- FILTSIM (filter simulation) 3 filters
- RUB & BUZZ (loudspeaker measurement) 1 filter
- WAVEFORM (DIGITAL or ANLG22kHz) 1 filter
- 1/3-OCTAVE 1 filter

can be selected and assigned to the ANALYZER function (see 2.7 Analyzer Filters (FILTER Panel)).

Note: *Apart from these filters of digital design, an analog notch filter can be switched on additionally with the analog measurement functions RMS, RMS SELECT, QPK and FFT for elimination of individual frequency lines (see menu item Notch (Gain) in this section).*

POST FFT

POST FFT is an FFT subsequent to the functions

- RMS & S/N
- THD+N/SINAD
- WOW & FL.

The input signal is sampled, the sampled values are stored and analyzed according to the selected measurement function. Subsequent to determination of the measurement result, an FFT is calculated and graphically displayed. Then, the measurement of the selected function is restarted and the activated filters, if any, begin to settle again.

For more details on the FFT including all its parameters, refer to Section 2.6.5.12.

ON

POST-FFT is calculated; however, it is displayed only, if the operation SPECTRUM has been selected in the DISPLAY panel.
With generator sweep, the end of the POST FFT algorithm determines the sweep stepping, thus reducing the sweep rate!
POST-FFT is switched on *coercively*, if the phase measurement is selected for the measurement function RMS (with two-channel measurement).

OFF

POST-FFT is not calculated.
This selection is made to achieve a maximum measurement speed.
POST-FFT is switched off *coercively*, if

- the S/N measurement or
- the special mode TRIGGERED FIX

is used for the RMS function.

FFT Size

Enter the FFT size (256 to 8192), see 2.6.5.12 FFT.

Start

Only display (no entries possible) of the frequency limits of the generated spectrum.

Stop

Resolution

Only display (no entries possible) of frequency resolution.

Window

Select the window function. Possible windows and their applications, see 2.6.5.12 FFT.

Notch (Gain)

For the functions RMS & S/N, RMS SELECT, Q PK & S/N and FFT, the three analog analyzers offer an analog notch filter of 2nd order to be activated for narrow-band suppression of interfering frequency lines. With notch switched on, one of 3 gain factors can be selected:

OFF Analog notch filter off

0 dB Analog notch filter on; no gain effective

12 dB Auto Analog notch filter on; gain 12 dB

30 dB Auto Analog notch filter on; gain 30 dB

Note: *If frequency components occur outside the analyzer frequency range, the notch gain may cause the analyzer to be overdriven. In this case, the notch gain is reduced step by step, which is to be indicated by adding "Auto" in the items 12 dB and 30 dB.*

Notch Freq

Selection of the notch-filter center frequency.

AUTO Center frequency of the notch filter tracks the measured frequency.

VALUE Numerical entry of the notch filter center frequency
Specified range: 10 Hz to 110 kHz
Units: Hz, kHz
Switching on VALUE causes the latest valid notch frequency to be displayed. When switching over from AUTO to VALUE, e.g., and the (external) test signal having a frequency of 117 kHz, the frequency displayed is 110 kHz.

GEN TRACK With the generator signal function set to SINE, BURST, SINE2 PULSE or SQUARE, the current generator frequency specified under generator menu item FREQUENCY is used as notch filter center frequency. Any other signal function leads to an error message.

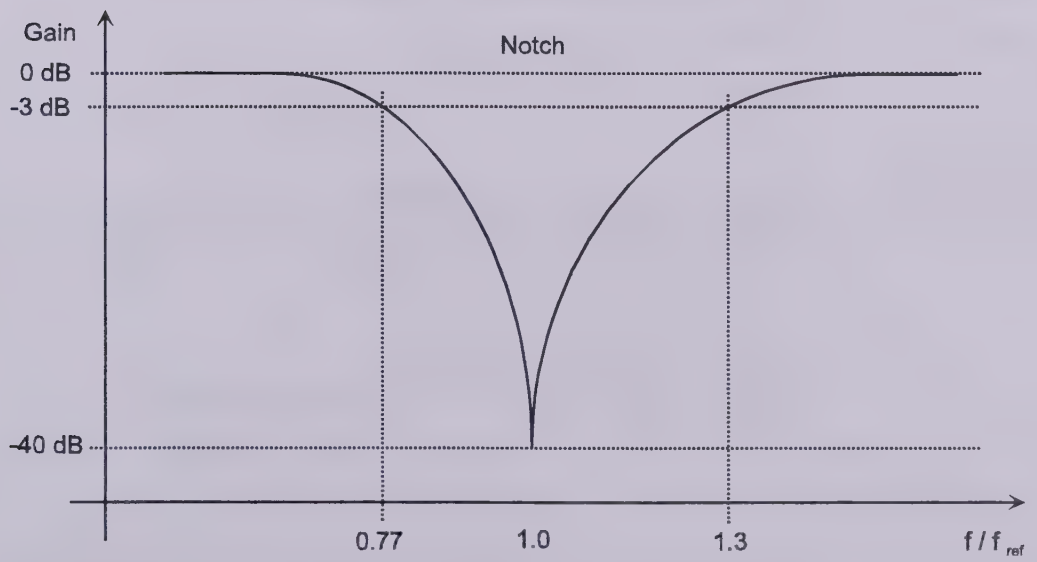


Fig. 2-20 Characteristic of analog notch filter

Application example: quantising noise measurement

The notch filter being subsequent to the input level stage, the fundamental wave level determines the dynamic range of the input circuit. The measurement range in which the fundamental wave is measured therefore determines the dynamic range of the quantising noise measurement.

Settling
Freq Settl
Phas Settl
Fnct Settl

Most measurements can be subceded by a settling or averaging procedure in order to obtain settled measured values even with settling DUTs.

Exceptions and special features:

- Settling cannot be realized with *group-delay measurement*, since the measured value is defined with varying frequency, only.
- From the physical point of view, settling is not required with the measuring functions *POLARITY* and *FILTSIM*
- The *WAVEFORM* function does not allow for selection of settling, but averaging (menu item Interpol).
- The *FFT* function does not allow for selection of settling, but it provides two different averaging modes (menu item Avg Mode NORMAL or EXPONENTIAL).
- The *1/3-OCTAVE* function does not allow for selection of settling; averaging is provided by setting of the measurement time.
- In the measurement modes *JITTER/PHAS* and *COMMON/INP* Settling cannot be selected, but with measurement functions *FFT* and *WAVEFORM* the averaging modes described above.

OFF

Settling process switched off; measurement result available in the shortest possible time. This setting should always be selected if maximum measuring speed is required.

EXPONENTIAL

Settling with exponential course of the tolerance and resolution.

FLAT

Settling with horizontal course of tolerance and resolution.

AVERAGE

Arithmetic averaging of the results

For further information, cf. 2.3.4 Settling Process

Samples

To menu item Settling → EXPONENTIAL | FLAT:
Number of subsequent measured values compared in the settling proces
If value 6 is entered here, this means that the latest measured value compared to 5 preceding measured values.
Specified range: 2 to 6

To menu item Settling → AVERAGE
Number of measured values used for arithmetic averaging.
Specified range: 2 to 100

Tolerance

To menu items Settling → EXPONENTIAL | FLAT:
The tolerance value denotes the maximally permissible deviation from the preceding measured value a settled measured value may have in order to be classed as valid by the UPL.
The value of the maximally permissible deviation of the current measured value compared to the 2nd/3rd/4th and 5th last measured value is determined by the setting EXPONENTIAL | FLAT .

For further information, cf. 2.3.3 "Settling Process"

Unit: % or dB (not WOW & FL and frequency measurement)
Specified range: 0.001 % to 10 % or
0.000087 dB to 0.828 dB

% and dB values can be converted into one another:

$$\% \text{ value} = \left(10^{\frac{\text{dB-value}}{20}} - 1\right) \times 100$$

$$\text{dB value} = 20 * \lg\left(\frac{\%\text{-value}}{100} + 1\right)$$

Resolution

To menu items Settling → EXPONENTIAL | FLAT:
Measured value resolution considered if the measured value does not satisfy the tolerance limits.

For further information, cf. 2.3.4 Settling Process

Specified range and units depend on instrument and measurement function:

- RMS & S/N | RMS SELECT | PEAK & S/N | Q PK & S/N | DC / external level sweep:
  analog: 0.1 µV to 10 V; VlmVlµVldBVldBulWlmWlµWldBm
  digital: Min. FS to 0.1 FS; FS |% FS |dBFS |LSBs | bits | Δ% | dBr
- THD+N/SINAD | THD | MOD DIST | DFD | WOW & FL:
  0.000001 % to 10 %; % | dB
- Frequency measurement / external frequency sweep:
  100 µHz to 10 Hz; Hz | kHz
- Phase measurement:
  0.0001 ° to 10 ° ° | RAD

Min. FS: $2^{(-1 * \text{audio bits})}$ however, not less than 1 µFS

Exception: a resolution of down to 1 nFS can be entered for the external level sweep so that the setting procedure can also be used for very small levels.

Time-out

If the settling mechanism does not recognize a stabilization of the measured value within the time stated under "time-out", the test loop is aborted and "Input - Press SHOW I/O" output instead of a measured value. A gap points to the missing value in the graphical curve display of a sweep.
For further information, cf. 2.3.4 Settling Process

Specified range: 0.001 to 10 s
Unit: s

Recommended Values:

For the majority of measurements on AF instruments, the following settings are suitable:

- Settling EXPONENTIAL
- Tolerance 1% (approx. 0.1 dB)
- Resolution:value of the last but one digit displayed in the result window, e.g., with a displayed value of 10.0000 Hz, this is 1 MHz
- Time-out 1 s

SPEAKER cf. 2.6.6 Headphone/Speaker Output

Pre Gain cf. 2.6.6 Headphone/Speaker Output

Spk Volume cf. 2.6.6 Headphone/Speaker Output

Phone Out cf. 2.6.6 Headphone/Speaker Output

2.6.5.2 RMS (incl. S/N)

Available in all analyzers.

Analog mode:

True rms measurements of AC voltages (frequency ranges of the analog ANALYZER instruments, see 2.6.1 Selecting the Analyzer) of any desired waveform up to 30 V. A superimposed DC is not measured (AC coupling).

Digital mode:

The signal contents is indicated as true rms full-scale value from 0.0 to 1.0.

Note: *If all converter bits are set, 1.0 FS (= 0.0 dBFS) is displayed.*

S/N Sequ

(see 2.6.5.1 Common Parameters of Analyzer Functions)

DC Suppres

Selectable in the digital analyzer only;
corresponding setting required for analog analyzers: AC/DC coupling, see 2.6.2 Configuration of the Analog Analyzers

Note: *DC suppression is only effective for the measured RMS value. With post-FFT a DC component is displayed even if DC suppression is switched on. A DC-free FFT display can only be obtained with the FFT measurement function.*

Meas Time

(Measure Time)

The rms measurement time serves to match the measurement rate to the signal frequency. It depends on the measurement requirements whether a short measuring time or high accuracy will have priority.

AUTO FAST
AUTO

Automatic matching of the measuring time to the signal frequency with consideration of the signal period. The measuring time is matched as far as possible to the input signal; with AUTO FAST, a maximum algorithmic error of 1% (with AUTO: 1‰) may arise. With very weak signals, the measuring time is limited to 1 period according to Min Freq.

Note: *In the case of very noisy or distorted signals, the automatic measurement modes - particularly AUTO FAST - may not be able to detect the signal period. To avoid measurement errors, these signals should preferably be measured with GEN TRACK or - if an external generator is used - with the measurement mode VALUE.*

Meas Time

(Measure Time)

VALUE

Numeric entry of desired measuring time. Since measurement errors may occur when the measuring time is not matched to the period, this mode should be selected only if the period of the signal is exactly known or no other measuring mode can be used. The measurement time should be an integral multiple of the period (to *avoid* errors due to termination of measurements) or at least much longer than the period time (to *minimize* such errors).

Specified range:
ANLG 22 kHz: 100 µs to 10 s
ANLG 110 kHz: 100 µs to 0.3 ms
DIGITAL: 100 µs to 10 s
Units: s | ms | µs | min

TRIGGERED

Special measurement mode; a single measurement (with selectable measuring time) is performed, as soon as the signal first exceeds a trigger threshold (also selectable). This measurement mode, in conjunction with a bursted generator signal, allows for measurement of the *first period* of a signal.

Application: *Anechoic measurements on loudspeakers, measurement of short signal pulses.*

Notes:

- *TRIGGERED should be selected with single-channel measurement with fixed voltage range, only.*
- *Triggering on level thresholds can be selected using START CONDition LEV TRG CH1/2, also.* ***Any*** *measuring function (e.g., WAVEFORM") can be selected. The measuring mode described here can, however, be used for RMS measurement, only. Advantage: the measurement starts* ***without delay****.*
- *In TRIGGERED mode, neither filters nor POST FFT nor Settling can be set.*

GEN TRACK

Measurement over (at least) one whole period of the generator signal. If required, the generator frequency is matched to the analyzer sampling rate. In the case of high frequencies the measurement time is extended to several periods to increase the measurement accuracy.
Particularly suitable for measuring very noisy or distorted signals and for extremely fast sweeps.

The period length is calculated from the signal frequency entered in the generator panel which is why this measuring mode should only be used with use of the UPL *function* generator.

Note: *When using the low-distortion generator, small frequency offsets may occur which may lead to a reduction of the measuring accuracy if the measuring time is coupled to the rated frequency. The measurement rate AUTO should be used in these cases.*

The fixed integration time specified with VALUE (without consideration of the signal period) leads to the following consequences depending on the meas. time/signal period ratio:

- Meas Time is integer multiple of signal period:
  Optimum integration effect. Steady display!
- Meas Time larger than, yet no integer multiple of signal period:
  Integration effect, however beats occur in the display.
- Meas Time smaller than signal period:
  No integration effect. AC measurement result follows the signal waveform.

Unit Ch1/2

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Sweep Mode

Displayed only in ANLG 22 kHz and DIG 48 kHz analyzers.

This menu item is provided to increase the speed of frequency sweeps with the universal generator of the UPL. To increase the sweep speed the following ***conditions*** have to be fulfilled by the ***generator***:

- Function SINE
- Low distortion OFF
- Sweep control AUTO ...
- X axis FREQ
- Z axis OFF

NORMAL

Normal sweep trigger without additional speed optimization; may be used for any kind of sweep.
This setting is used internally whenever one of the conditions for optimized sweep synchronization is not met, e.g. in the "learn mode" (see below).

BLOCK

Speed-optimized sweep:
The 1st sweep is always performed with the speed set under NORMAL. During this sweep the generator parameters for the subsequent sweeps are learned and stored (learn mode).
As long as no settings are done in the instrument, the BLOCK mode can use the learned parameters as from the 2nd sweep (play mode) so that setting times for the individual sweep points are considerable shortened. For reasons of speed, measured values are not indicated. Traces are displayed when the sweep is completed.
During a sweep the instrument cannot be operated. If one or several keys are pressed during the sweep, the current sweep is terminated and the unit returns to the learn mode where the functions of the pressed keys are performed.

Note: *Settling cannot be switched on in the block mode.*

Notch (Gain)

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Filter

(see 2.7 Analyzer Filters (FILTER Panel))
Maximum 3 filters can be selected.

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Post FFT

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Switching on the POST FFT improves the digital frequency-measurement result for frequencies above 4 times the FFT resolution. This can be noticed in particular with high frequencies and/or noisy signals.

POST FFT is switched on coercively, if phase or group-delay measurement is switched on - with two-channel measurement. Since these measurements cannot be performed unless (POST) FFT is selected, the latter cannot be switched off until frequency measurement is set OFF or to FREQ again.

The POST FFT is switched off automatically with selecting TRIGGERED measuring time or switching on S/N measurement.

Note: *With active Post-FFT a DC part that might exist is always displayed in the FFT spectrum, e.g. even when DC suppressing is switched off. A DC free FFT display can be achieved via measurement function FFT.*

Trig Level

(Trigger level); is displayed with Meas Time TRIGGERED, only.

Sets the trigger threshold which determines the start of the RMS measurement. The trigger level applies in relation to the full-scale value selected under menu item Ch1/2 Range as fixed voltage range.

Specified range:-240 to 0 dB
Unit: % or dB

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.3 RMS SELECT (Selective RMS Value)

Available in all analyzers. Selective RMS measurement with narrow bandpass or bandstop.

DC Suppres

Selectable in the digital analyzer only;

corresponding setting for analog analyzers:
"Coupling AC/DC", see 2.6.2 Configuration of the Analog Analyzers

Meas Time

(Measure Time) serves to match the measurement rate to the signal frequency. It depends on the measurement requirements whether a short measuring time or high accuracy will have priority.

AUTO FAST
AUTO

Automatic matching of the measuring time to the signal frequency with consideration of the signal period. The measuring time is matched as far as possible to the input signal; with AUTO FAST, a maximum algorithmic error of 1% (with AUTO: 1‰) may arise. With very weak signals, the measuring time is limited to 1 period according to Min Freq.

Note: *In the case of very noisy or distorted signals, the automatic measurement modes - particularly AUTO FAST - may not be able to detect the signal period. To avoid measurement errors, these signals should preferably be measured with GEN TRACK or - if an external generator is used - with the measurement mode VALUE.*

VALUE

Numeric entry of desired measuring time. Since measurement errors may occur when the measuring time is not matched to the signal period, this mode should only be used if the signal period is exactly known or the other measurement modes cannot be used. The measuring time should be an integral multiple of the period (to *avoid* errors due to termination of measurement) or be at least much longer than the period (to *minimize* such errors).

Specified range:
ANLG 22 kHz: 100 µs to 10 s
ANLG 110 kHz: 100 µs to 0.3 ms
DIGITAL: 100 µs to 10 s
Units: s | ms | µs| min

GEN TRACK

Measurement over (at least) one whole period of the generator signal. If required, the generator frequency is matched to the analyzer sampling rate. In the case of high frequencies the measuring time is extended to several periods to increase the measurement accuracy. Particularly suitable for measuring noisy or distorted signals and for very fast sweeps.

The period length is calculated from the signal frequency entered in the generator panel which is why this measuring mode should only be used with use of the UPL *function* generator.

Note: *When using the low-distortion generator, small frequency offsets may occur which can lead to a reduction of the measuring accuracy if the measuring time is coupled to the rated frequency. The measurement rate AUTO should be used in these cases.*

Unit Ch1/2

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Bandwidth

Bandwidth of bandpass (BP) or bandstop (BS)

BP 1%
BS 1%

Geometrically symmetrical bandwidth 1%

BP 3%
BS 3%

Geometrically symmetrical bandwidth 3%

BP 1/3 OCT
BS 1/3 OCT

Geometrically symmetrical bandwidth ≈ 23%

(obtained from $\sqrt[6]{2} - \frac{1}{\sqrt[6]{2}} = 0.2315 = 23.15\%$)

BP 1/12 OCT
BS 1/12 OCT

Geometrically symmetrical bandwidth ≈ 6%

(obtained from $\sqrt[24]{2} - \frac{1}{\sqrt[24]{2}} = 0.0577 = 5.77\%$)

BP FAST
BS FAST

same as BP/BS 1/3 OCT, for 40 dB attenuation only
but with considerably shorter settling time.

BP FIX:
BS FIX:

Arithmetically symmetrical bandwidth using numerical entry

Analyzer	Range for bandwidth
ANLG 22 kHz	9.9 Hz to 16 kHz
ANLG 110 kHz	70.4 Hz to 113.8 kHz
DIGITAL	$f_{cmin} * 0.99 ... \frac{\text{sample freq.}}{3}$

$f_{cmin} = \frac{\text{sample freq.}}{4800}$ (minimum center freq.)

Units: Hz, kHz

Note: *For Third Octave filters the 0,1dB-bandwidth is reduced in order to obtain an attenuation of 3 dB at the cut-off frequencies. Hence the effective bandwidth is lower than the theoretical value.*

Note: *It may occur in the analog analyzer 110 kHz that the selection filter cannot settle - due to low frequencies and narrow passband or stopband. If this is the case,*

- *increase the passband or stopband, or*
- *increase the filter center frequency, or*
- *use the analyzer 22 kHz.*

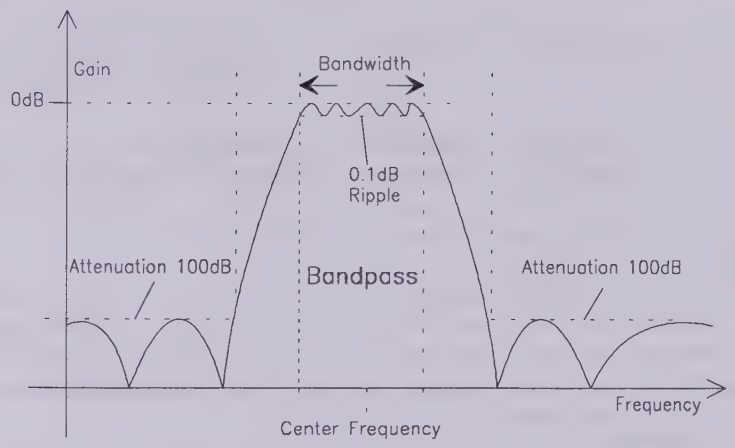


Fig. 2-21 Bandpass used for selective rms measurement

Frequency Sweep of Selective RMS Measurement

The band center frequency of the selective rms measurement can be swept using various procedures. A table with a maximum of 1024 frequency entries is generated. As desired, the individual frequency points can be

- calculated from user specifications (SWEEP CTRL → AUTO SWEEP | MANU SWEEP)
- loaded from file as list sweep (SWEEP CTRL → AUTO LIST | MANU LIST)
- derived from the individual frequencies of generator MULTISINE (SWEEP CTRL →GEN MLTSINE).

SWEEP CTRL (Sweep Control)

is used to select whether and how to sweep the band center frequency. The notch frequency of the switch-selectable analog notch filter is swept additionally, with analog analyzers.

OFF

The sweep system is switched off. The band center frequency can be selected via menu item FREQ MODE (see below).

Note: *With this setting, the sweep system is available for generator or analyzer sweeps. By selection of FREQ MODE and switching on a generator frequency sweep or external frequency sweep the band center frequency can be swept over the generator frequency or over the frequency of an external generator.*

AUTO SWEEP

Pressing the START or SINGLE key causes the sweep to run automatically (see 2.11 Starting and Stopping of Measurements or Sweeps).
The sweep parameter data are calculated from the user specifications (start/stop values and step size or number of points); "normal" sweep

SWEEP CTRL

AUTO LIST	Pressing the START or SINGLE key causes the sweep to run automatically (see 2.11 Starting and Stopping of Measurements or Sweeps). The sweep parameter data are read from a file (list sweep);
MANU SWEEP	The sweep is controlled by means of the rotary knob and/or cursor keys. After pressing the START key, only the first frequency of the selective rms measurement is set. Any further frequency is requested using the rotary knob or by pressing a cursor key (see 2.11 Starting and Stopping of Measurements or Sweeps). When sequencing the manual sweep, the result of the current measurement is not waited for, i.e., the current RMS SELECT measurement and an analyzer delay, if set, are aborted. As with AUTO SWEEP, the sweep parameter data are calculated from the user specifications (start/stop values and step size or number of points); "normal" sweep
MANU LIST	The sweep sequence is similar to MANU SWEEP; the sweep parameter data are, however, read from a file (similar to AUTO LIST); (List Sweep).
GEN MLTSINE	(Generator multisine) The band center frequency of selective RMS measurement is subsequently set to the multisine frequencies entered in the generator panel (see 2.5.4.4 MULTISINE). The generator signal function is assumed to be set to MULTISINE. This setting is used for fast measurement of the frequency response. The sweep runs automatically upon depression of the START or SINGLE key (see 2.11 Starting and Stopping of Measurements or Sweeps).

Notes on manual sweep:

In order to control manual sweeps using the rotary knob or the cursor keys, the graphics panel must be active (full-screen or part-screen mode). When the sweep is started, the switchover to the graphics panel occurs automatically. The feature "manual sweep" can be used to vary the band center frequency with a user-definable increment. The increment is defined by a fixed STEP (with MANU SWEEP) or by a variable step size defined in a file (with MANU LIST). With remote control, the command "INIT:NEXT<n>" is used to continue.
Subsequent to setting a new sweep point, a continuous measurement is performed on this point. All measured values thus obtained can be read off from the display or from the curve plot (in the form of crosses). With sweep sequencing, the value *last* measured is stored.
By turning the rotary knob fast, individual sweep points can be skipped (to be recognized as gaps in the graphical curve display), or repeated by turning the rotary knob back.
The measured values are indicated by crosses in the Curve Plot mode. If Scan count >1 has been selected in the display panel, the crosses are not deleted prior to a new character, but remain on the screen. With strongly fluctuating measured values, the representation approximately takes the shape of a bar. If sweep steps are skipped or advanced too fast, a NAN value (Not A Number) is entered. When reaching the end of the sweep, the complete trace (with the last measured values, respectively) is obtained.

Spacing

Spacing of the sweep ranges for menu items

SWEEP CTRL → AUTO SWEEP | MANU SWEEP

LIN POINTS

The sweep range between Start and Stop is linearly spaced by a number of points which is to be entered under menu item "Points".
The step size in Hz can be derived from the number of linear points:

$$Step[Hz] = \frac{|Stop[Hz] - Start[Hz]|}{Points - 1}$$

LIN STEPS

The sweep range between Start and Stop is spaced in frequency intervals determined by the linear step size in Hz which is to be entered under menu item "Step".
The number of points can be calculated from the linear step size in Hz:

$$Points = \frac{|Stop[Hz] - Start[Hz]|}{Step[Hz]} + 1$$

LOG POINTS

The sweep range between Start and Stop is logarithmically spaced by a number of points to be specified under menu item "Step".
The multiplier for the step size can be derived from the number of logarithmic points:

$$Step = \left(\frac{Stop[Hz]}{Start[Hz]}\right)^{\frac{1}{Points-1}}$$

LOG STEPS

The sweep range between Start and Stop is spaced using a logarithmic step size which is to be entered under menu item "Step" as multiplier without unit.

Note: *When switching from ...POINTS to ...STEPS, no conversion is performed. The set values are retained in the background. When switching between LIN STEPS and LOG STEPS, the numerical value specified for "Steps" remains the same.*

Start

Displayed with normal sweep only (SWEEP CTRL → AUTO SWEEP | MANU SWEEP).

Stop

Entry of the start and stop value for the sweep of the band center frequency.
For the specified range and units, see FREQ MODE → FIX.

Points

Displayed with normal sweeps (SWEEP CTRL → AUTO SWEEP | MANU SWEEP) if the spacing LIN POINTS or LOG POINTS has been selected.

Enter the number of points for the frequency sweep of the band center frequency.

Specified range: 2 to 1024
Units: integer value without unit

Step

Displayed with normal sweeps (SWEEP CTRL → AUTO SWEEP | MANU SWEEP) if LIN STEPS or LOG STEPS has been selected with Spacing.

Enter the step size for the frequency sweep of the band center frequency.
Specified range:
The step size must be selected such that max. 1023 single steps (= 1024 sweep points) result. The step size must not be larger than the absolute difference between Stop and Start.
For the valid specified range, see operator guidance line.

Units with	Spacing → LIN STEPS:	Hz | kHz
	spacing → LOG STEPS:	no unit, because of multiplier

Filename

Displayed with list sweeps only (SWEEP CTRL → AUTO LIST | MANU LIST) if LIN POINTS or LOG POINTS has been selected.

File containing the frequency values for the frequency sweep of the band center frequency. (For the format of the sweep lists, see Appendix).

FREQ MODE

Displayed with bandpass center frequency switched off, only (SWEEP CTRL → OFF).

Specification of the band center frequency.
With analog analyzers, this implies specification of the notch frequency of the switch-selectable analog notch filter.

FIX

Numerical entry of a fixed bandpass center frequency, i.e., also notch frequency, if notch switched on (menu line NOTCH (Gain) in the analog analyzers).
The minimum and maximum possible center frequency is determined by the instrument selected and the bandwidth specified and displayed in the operator guidance line. (For table with values, see below.)

For other measurement spheres, the generator can be swept, however does not cause any change in frequency of the selective rms measurement.

GEN TRACK

(Generator tracking)
The bandpass center frequency - and also the notch frequency (menu line Notch(Gain) in the analog analyzers), if switched on - tracks the generator frequency. This can be varied by the user (entry of value, rotary knob in menu item "FREQUENCY" of the generator) or by a generator frequency sweep.
By means of the factor entered in the next menu line it can be determined whether the center frequency should directly track the generator frequency (factor = 1) or be a multiple thereof. If the factor is an integral multiple, it may be used for measuring single harmonics.
The bandpass center frequency can be tracked to the generator signal functions SINE, MULTISINE, BURST or SINE2 PULSE", only; any other signal function causes an error message.

Note: *When using the low-distortion generator, small frequency offsets may occur which may lead to incorrect measurements if the band center frequency is coupled to the rated frequency and the actual frequency is out of the selected passband or stopband. The measured frequency should be used in these cases (FREQ MODE MEAS CH1/2).*

FREQ CH1
FREQ CH2

The bandpass center frequency - and also the notch frequency (menu line Notch(Gain) in the analog analyzers), if switched on, tracks the frequency measured on channel 1 or 2.

Note: *Switching over the input channels 1↔2 causes the frequency mode FRQ CH1 ↔ FRQ CH2 to be switched over, too.*

Factor

Displayed only with FREQ MODE → GEN TRACK.

Specifies the factor by which the center frequency of the bandpass or bandstop filter is higher than the generator frequency. An integral factor >1 allows a single harmonic to be measured. With the factor 1 the fundamental can be selected.

Specified range: 1 to 20

Note: *The factor does not affect the notch filter frequency. With GEN TRACK selected, the notch filter is set exactly to the generator frequency without considering the "factor" so that a wider dynamic range can be obtained through the suppression of the fundamental irrespective of the measurement task.*

Sweep Mode

Displayed only with FREQ MODE → GEN TRACK in the ANLG 22 kHz and DIG 48 kHz analyzers.

This menu item is used to increase the speed of frequency sweeps using the built-in universal generator. To increase the sweep speed the following ***generator conditions*** must be fulfilled:

- Function SINE
- Low distortion OFF
- Sweep control AUTO to
- X axis FREQ
- Z axis OFF

I

n addition, the following settings have to be made in the ***ANALYZER panel***:

- Freq Mode GEN TRACK
- Notch (Gain) OFF (recommended)

Description:
The 1st sweep is always performed with the speed set under NORMAL. During this sweep the filter and generator parameters for the subsequent sweeps are learned and stored (learn mode).
As long as no new settings are made in the instrument, the FAST and BLOCK mode can use the learned parameters as from the 2nd sweep (play mode) so that setting times for the individual sweep points are considerable shortened.
If the start key is pressed or a instrument setting made, the (slower) learn mode is selected.

Note: *In the play mode, measured values are not indicated in the result display for reasons of speed.*

NORMAL

Normal sweep without additional speed optimization; may be used for any kind of sweep. This setting is used internally whenever one of the conditions for optimized sweep synchronization is not met, e.g. in the learn mode (see below).

FAST

Speed-optimized sweep without any operational restrictions. Measured values are not indicated for reason of speed.

BLOCK

Further speed optimization of sweep but in this case the instrument cannot be operated during the sweep. If one or several keys are pressed, the sweep is terminated and the FAST mode is selected where the functions of the pressed keys are executed. Measured values are not indicated for reasons of speed; traces are displayed upon completion of the sweep.

Notch (Gain)

(see 2.6.5.1 Common Parameters of Analyzer Functions)
An analog notch can be switched on additionally in the analog analyzers to improve the stopband attenuation.

The notch frequency is coupled directly to the band center frequency of the selective filter, i.e., it is selected via the menu FREQ MODE.

Filter

(see 2.7 Analyzer Filters (FILTER Panel))
In addition to the selective filter and the analog notch, another (digital) filter can be selected.

***Application**: Highpass filter for DC suppression.*

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

Specified range for the bandpass center frequency:

The minimum and maximum possible center frequency is determined by the instrument selected and the bandwidth specified and is displayed in the operator guidance line.

Analyzer	f_c with bandwidth 1%	f_c with bandwidth 3%	f_c with bandwidth 1/3 OCT	f_c with bandwidth 1/12 OCT	f_c with bandwidth FIX:
ANLG 22 kHz	10 Hz to 21.83 kHz	10 Hz to 21.61 kHz	10 Hz to 19.54 kHz	10 Hz to 21.31 kHz	$5{,}05\,\text{Hz} + \frac{bw_{fix}}{2} \ldots f_{N1} - \frac{bw_{fix}}{2}$
ANLG 110 kHz	64 Hz to 119.4 kHz	64 Hz to 118.2 kHz	64 Hz to 106.2 kHz	64 Hz to 116.6 kHz	$35{,}91\,\text{Hz} + \frac{bw_{fix}}{2} \ldots f_{N2} - \frac{bw_{fix}}{2}$
DIGITAL	$f_{cmin} \cdots \frac{f_N}{1{,}005}$	$f_{cmin} \cdots \frac{f_N}{1{,}015}$	$f_{cmin} \cdots \frac{f_N}{1{,}12246}$	$f_{cmin} \cdots \frac{f_N}{1{,}0293}$	Sample freq. * 0.1052E-3 + $\frac{bw_{fix}}{2} \ldots f_{N-} \frac{bw_{fix}}{2}$

f_c = Bandpass center frequency

f_{cmin} = $\frac{\text{Int. sample freq.}}{4800}$ (minimum center frequency)

f_N = Int. sample freq.* $\frac{117}{256}$ (useful frequency)

bw_{fix} = bandwidth entered in numerical form

f_{N1}=21.94 kHz

f_{N2}=125 kHz

Notes on aural monitoring of residual signal:

Aural monitoring of the residual signal with the RMS selective measurement switched on is possible with the frequency-controlled universal generator (`Low Dist = OFF`*), with setting* `FREQ MODE = GEN TRACK` *and the narrow bandstop filter* `Bandwidth = BS 1%`*. When the generator frequency is varied, the fundamental is suppressed by the bandstop filter.*
If the low-distortion generator is used (`Low Dist = ON`*), which offers a purer spectrum but not quite the frequency accuracy of the universal generator, the generator frequency may be slightly outside the range of the BS 1% bandstop filter. Thus the fundamental is not completely suppressed.*

Remedy:
Select a wide bandstop filter (`BS 3%, BS 1/3 OCT, 1/12 OCT`*) or set* `FREQ MODE = FIX` *with the desired center frequency for the RMS selective measurement and vary the frequency of the low-distortion generator in the GENERATOR panel by a few Hz to adjust the generator frequency exactly to the bandwidth of the bandstop filter.*
To be able to continuously monitor the residual signal, a frequency measurement must not be selected in the ANALYZER panel, as for a frequency measurement all filters in the UPL have to be switched off for a brief period of time, i.e. also the RMS-selective bandpass or bandstop filter:
`FREQ/PHASE = OFF,`

`FREQ MODE` *not* `FREQ CH1 | FREQ CH2.`

2.6.5.4 PEAK, Q-PEAK (Peak and Quasi-peak Weighting incl. S/N)

Available in the analyzers ANLG 22 kHz and DIGITAL.

PEAK measurement

Peak value detector follows the waveform without delay.

Quasi-PEAK measurement

Peak value detection with subsequent and defined rising and falling times. This measurement is used for interference voltage measurements to CCIR 468-4 and DIN 45405.

In the peak and quasi-peak measurement, the maximum peak value of the input signal is determined and displayed within the monitoring interval selected under menu time "Intv Time". Subsequently, the peak value memory is cleared and the next peak value is searched for. The principle of operation is comparable to that of a maximum pointer instrument.

As to the measurement:

- *With the use of the analog analyzer an internal DC offset is also part of the measured value. The DC offset can be minimized using the CALIBRAT function in the OPTION panel.*
- *When applying a squarewave signal, it is bandlimited by the upper limit of the selected analyzer, leading to overshoots at the edges (Gibb's phenomenon). The overshoots are also measured during peak weighting, which may lead to a measured value exceeding the input peak. Particularly in the digital range, full-scale values > 1 may be measured (see 2.4 Units).*

S/N Sequ	(S/N Sequence) (see 2.6.5.1 Common Parameters of Analyzer Functions)
Meas Mode	(Measurement Mode) of PEAK measurement (see 2.4 Units).
PK +	The peak positive voltage is measured
PK -	The (absolute) peak negative voltage is measured
PK to PK	The peak-to-peak voltage is measured
PK abs	The absolute peak voltage (positive or negative) is measured

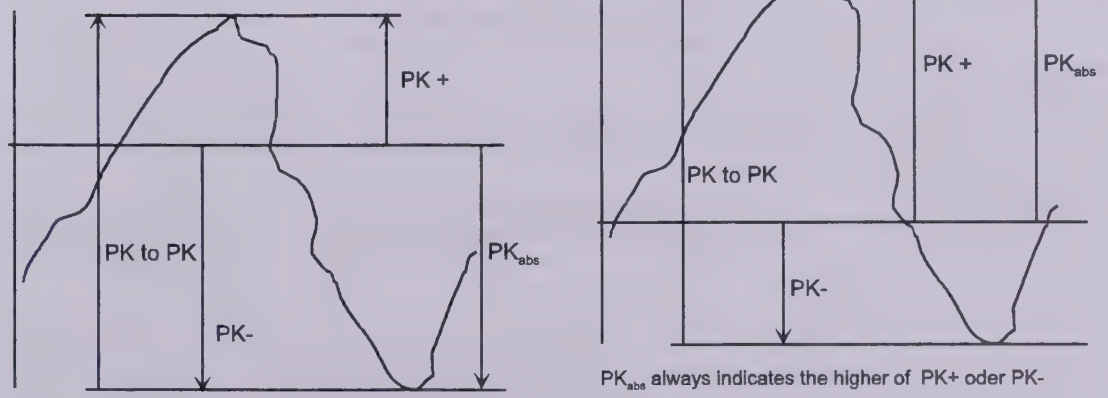


Fig. 2-22 Signal with the measurement modes

Intv Time

(Interval Time)
Monitoring interval for peak value detection
Selection depends on the type of input signal and measurement sphere.
Universal specifications cannot be made.

FIX 50 MS	50 ms PEAK only
FIX 200 MS	200 ms PEAK only
FIX 1000 MS	1000 ms PEAK only
FIX 3 SEC	3000 ms PEAK only
VALUE	Numerical entry. Range of value: 20 ms to 100 s, Units: s I ms I µs I min

Notes on quasi-peak measurement:
In order to obtain settled measured values, the measuring time should not drop below 3 s with triggered measurements and sweeps.

Unit Ch1/2

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Notch (Gain)

quasi peak only
(see 2.6.5.1 Common Parameters of Analyzer Functions)

Filter

(see 2.7 Analyzer Filters (FILTER Panel)
Maximum 3 filters can be selected.

Fnct Setti

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

2.6.5.5 DC

Principle of measurement

DC voltages can be measured from 0 to ±30 V. The DC reference point is the connecting point 3 of the XLR female connectors (see 2.6.2). For selecting the measurement range for DC measurements, see 2.6.2, Range Table.

During a DC measurement, overloading of the measurement path caused by a superposed AC voltage causes a less sensitive range to be automatically set, which however means less measuring accuracy.

Meas Time

If the DC voltage is superposed by an AC voltage, specifying the Meas Time as integration time relative to the signal period of the AC voltage has different effects:

Meas Time is an integer multiple of signal period:
An integration effect results. The AC voltage is ***not*** included as part of the DC measurement result. Steady display!

Meas Time larger than, yet no integer multiple of signal period:
As above, yet beats occur in the display

Meas Time smaller than signal period:
No integration effect. The AC voltage is included as part of the DC measurement result. The DC measurement result follows the course of the AC voltage.

FIX 200 MS

Measuring time 200 ms

VALUE

Numerical entry.
Specified range: 100 µs to 1.5 s
Units: s | ms | µs | min

Unit Ch1/2

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

2.6.5.6 THD Measurement

Available in all analyzers.

For distortion measurements, apply an extremely pure sinewave signal to the device under test. Select the signal frequency such that the significant components of the distortion spectrum are still below the upper range limit (see 2.6.1, 2.6.2, 2.6.3) of the selected ANALYZER instrument.

A signal not meeting the requirements leads to a SHOW I/O message (see 2.3.5):

The signal has no zero crossings and is not suitable for distortion measurements:
"Can't find zero crossing in Signal"

With the signal function SINE (see 2.5.4.3) in combination with the low-distortion generator (UPL-B1 option), the generator in the UPL offers a sinewave signal meeting the high demands on its spectral purity.

Principle of measurement

The UPL offers the possibility of distortion measurements over single harmonics or combinations thereof (d2 to d9), the amplitudes of the single harmonics being selectively measured and their square sum put in relation to the total rms value. As against the THD+N measurement (see 2.6.5.7 THD+N/SINAD measurement), broadband noise is not considered in the THD measurement due to the selective harmonics measurement.

$$U_{THD}[dB] = 20 \times \log \frac{\sqrt{Ud2^2 + ... + Ud9^2}}{\text{total rms value}}$$

$\sqrt{Ud2^2 + ... + Ud9^2}$: square sum of selected harmonics

Display of the measurement result:

Apart from displaying the THD in the result display, an additional graphical (histogram) or numerical display of the fundamental and the individual harmonics can be switched on. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel. All harmonics in the frequency range are indicated in the histogram. The selected harmonics which are contained in the result are marked by wide bars, the other ones by narrow bars, so that they can be distinguished.

Note: *If the fundamentals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

Meas Mode

(Measurement Mode)
Select the harmonics to be measured and the way of display. The harmonics are then displayed above the measured value window. "THD 2–4–6–8", for example, means that the 2nd, 4th, 6th and 8th harmonics are measured.

SELECT di	Any combination of harmonic distortions d2 to d9. The measurement result is the root from the square sum of the selected harmonic distortion ***referred to the total RMS value***. Display in % or dB.
All even di	Like SELECT di, all ***even*** harmonics distortions (d2, d4, d6, d8) being selected.
All odd di	Like SELECT di, all ***odd*** harmonic distortions (d3, d5, d7, d9) being selected.
All di	Like SELECT di, ***all*** harmonic distortions (d2 to d9) being selected.
LEV SEL di	Any combination of harmonic distortions d2 to d9. The measurement result is the root from the square sum of the selected harmonic distortion, display as ***RMS value*** (with any level unit).
LEV even di	Like LEV SEL di, all ***even*** harmonics distortions (d2, d4, d6, d8) being selected.
LEV odd di	Like LEV SEL di, all ***odd*** harmonic distortions (d3, d5, d7, d9) being selected.
LEV all di	Like LEV SEL di, ***all*** harmonic distortions (d2 to d9) being selected.

di 2 4 6 8

is displayed only, if either SELECT di or LEV SEL di has been selected with Meas Mode.

√	**d2**
	d3
√	**d4**
	d5
√	**d6**
	d7
√	**d8**
	d9

Upon selection of the desired harmonic distortions using the ↑ and ↓ keys, the harmonic distortion measurement can be selected (√) or disabled by pressing the SELECT key.

Dyn Mode

(Dynamic Mode) only with analog analyzers,
determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with less dynamic is performed.

PRECISION

The measurement is performed with higher dynamic and with the analog notch filter cut in. The notch filter is suitable for measurements up to 22.5 kHz - i.e. there are no restrictions in the ANLG 22-kHz instrument. Signals with a fundamental ≤ 22.5 kHz can be measured in the ANLG 110-kHz instrument. Signals with a fundamental > 22.5 kHz cause the error message "Frequency exceeds notch range" to be output.

The measuring time is longer in the PRECISION mode.

Unit

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(See 2.6.5.1 Common Parameters of Analyzer Functions)
only available in level measurement modes (LEV...).

This value may be entered manually if desired. Otherwise, the current RMS value will be automatically entered, if the reference value of INPUT DISP RMS is stored with the STORE (or STORE CH1 or STORE CH2) function.

Fundamental

Specifies how the fundamental is to be determined.

AUTO

UPL automatically determines the fundamental (during a THD measurement).

AUTO should always be used when the signal is derived from a low-distortion generator or an external generator and the signal has not an extremely high harmonic content.

VALUE

Numerical entry of fundamental
Specified range:

ANLG 22 kHz:	6 Hz to 21.9 kHz
ANLG 110 kHz:	38 Hz to 125 kHz
DIGITAL:	sample frequency/8192 to useful bandwidth

Useful bandwidth = sample frequency * 117/256

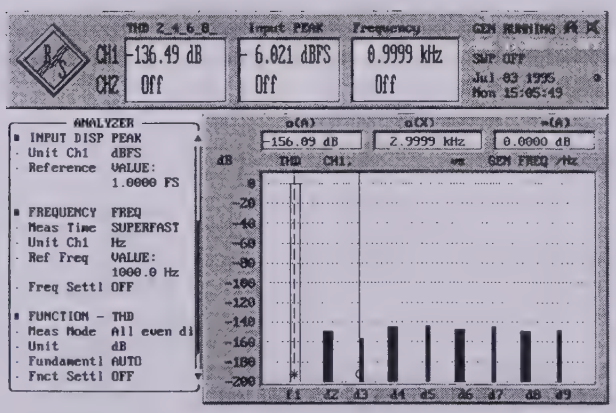
VALUE should be preferred for signals with a high harmonic content derived from an external generator.

GEN TRACK

UPL takes the fundamental from the frequency setting of the generator. This improves the setting accuracy for signals with a high harmonic content.

GEN TRACK should be used when the signal is derived from the internal universal generator.

Note: *When the internal low-distortion generator is used, the generator frequency is accurately measured and the fundamental corrected, if required. Thus the measurement result is not influenced by the frequency inaccuracy of the generator (e.g. temperature drift).*



Graphical presentation of THD measurement results
in the form of a histogram see 2.10.1 and 2.10.2

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

2.6.5.7 THD+N/SINAD Measurement (Total Harmonic Distortion+ Noise)

Available in all analyzers.

For THD or SINAD measurements, apply a highly pure sinewave signal to the device under test. Select the signal frequency such that the significant components of the THD spectrum are still below the upper measurement limit (see 2.6.1, 2.6.2, 2.6.3) of the used ANALYZER instrument.

If the signal offered does not meet the requirements, a SHOW I/O message is output (see 2.3.5):

- In the frequency range, the fundamental wave cannot be found:

  "Can't find fundamental"

- The frequency of the found fundamental wave is less than the lower limit value (for its calculation, see below, Fundamental VALUE):

  "Fundamental too low"

With the signal function SINE (see 2.5.4.3) in combination with the low-distortion generator (UPL-B1 option), the generator in the UPL offers a sinewave signal meeting the high demands on its spectral purity.

Principle of measurement

The fundamental is filtered out and the remaining energy consisting of harmonics and broadband noise within the band limits specified under "FrqLim Low" and "FrqLim Upp" is calculated in one or several FFT procedures. The user can select the size of the *first* FFT for starting the calculation,

- implicitly by selecting measurement time (with post FFT switched off)
- explicitly by selecting FFT size (with post FFT switched on).

A compromise has to be made between measurement speed and measurement accuracy. If the FFT size is not sufficient to measure the fundamental of the measurement signal, the FFT size and if required the zoom factor can be increased in steps.
The energy of the noise and harmonics can either be displayed as an rms value or related to the total rms value, the total rms value being bandlimited to "FrqLim Upp". The selection is made under the menu item "Meas Mode". Depending on the selected measurement mode, different units are used:

- V or FS for rms display
- % or dB for the ratio display

In the measurement modes NOISE and LEVEL NOISE, all harmonics are filtered out in addition to the fundamental. With every harmonic also the noise energy of the respective sideband is filtered out. In the case of very low frequencies - and theoretically a great number of harmonics - a considerable amount of the noise energy is thus lost. These measurement modes should therefore only be used for higher frequencies (> 100 * FFT resolution) and large FFT size.

Measurement limits

The lower frequency limit for the signal is 10 Hz (or 20 Hz in the ANLG 110 kHz). The frequency of the fundamental must be limited at the upper end so that the harmonic to be measured is still below the limit frequency of the analyzer used or below the selected "FrqLim Upp". For measurements in the dynamic mode PRECISION, the fundamental (in the ANLG 110 kHz analyzer) should not be higher than 22.5 kHz (upper frequency limit of built-in analog notch filter).
For noise measurements (in the measurement modes NOISE and LEVEL NOISE, with harmonics not being taken into account) the fundamental must be at least 36 times the minimum resolution (displayed under Post FFT). In the ANLG 22-kHz analyzer and at a sampling rate of 48 kHz in the digital analyzer, a lower limit of 105.6875 Hz is obtained, in the ANLG 110 kHz analyzer 675 Hz.
THDN Post FFT is only possible if the fundamental of the measurement signal is by a multiple (depending on the selected analyzer) above the resolution selected under Post FFT (see FFT size). To reduce the resolution and thus the lower frequency limit, the FFT size may have to be increased.

Measurement speed

The measurement speed depends on the (selected) FFT size and the required dynamic measurement range.
The required FFT size is obtained from the frequency of the signal to be measured and the desired accuracy. The wider the FFT, the finer the frequency resolution and the lower the lower frequency limit. Consequently, a wide FFT has to be used for low frequencies or high accuracy requirements so that a longer measurement time has to be accepted.
For measuring particularly low-distortion signals, the measurement range can be extended by selecting the Precision mode with the result that the measurement time is doubled.
To obtain the highest possible measurement speed, two parameters can be optimized:

- Select smallest FFT size or adapt the FFT size to the fundamental of the measurement signal. The FFT size should be large enough so that the fundamental to be measured is at least 10 times greater (8.5 times in the ANLG 110, 12 times in the digital analyzer) as the resolution displayed under Post FFT. Only then can be total signal be measured with one single FFT. If the UPL generator is used as a signal source, *Fundamental GEN TRACK* and *FFT Size 512 ("Meas Time SUPERFAST".)* should be selected.
- Select *Dynamic Mode FAST* if the signal does not require the full dynamic measurement range.

Display of measurement result:

In addition to the total harmonic distortion (in the result display), its frequency spectrum can also be represented graphically or numerically as POST FFT. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

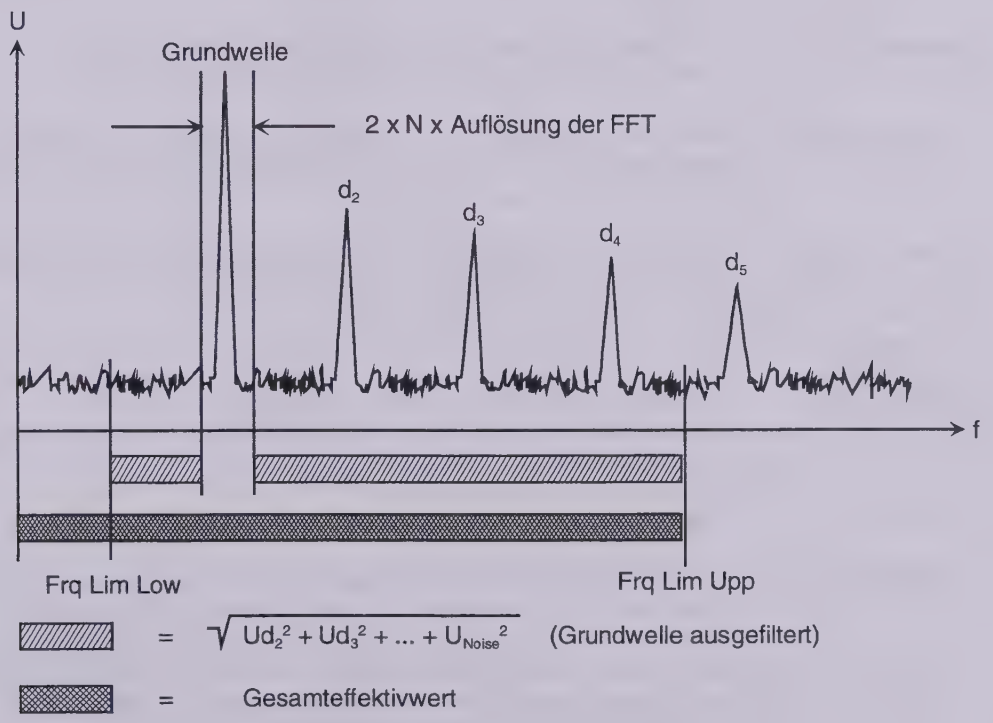


Fig. 2-23

N = 12 for digital analyzer
10 for ANLG 22 kHz
8.5 for ANLG 110 kHz

$$U_{THD+N}[dB] = 20*\log\frac{\sqrt{U_{d2}{}^2+U_{d3}{}^2+...+U_{noise}{}^2}}{\text{total rms value}}$$

THD+N measurements provide negative dB-values, SINAD measurements result in positive dB-values. The magnitudes of the values are identical.

$\sqrt{U_{d2}{}^2+U_{d3}{}^2+...+U_{noise}{}^2}$ = Square sum of all harmonic distortions+ noise within the frequency range specified under FrqLim Low and FrqLim Upp.

Meas Mode

(Measurement mode)
Selection of the measurement and display modes. The measurement mode selected is displayed above the measured value window.

THD+N

The THD including noise is measured, the result is the root from the square sum of the selected harmonic and the noise voltage, ***referred to the total RMS value***, display in % or dB.

SINAD

Like THD+N, however, displayed as reciprocal value; display only (positive) dB.

NOISE

The noise is measured, only; the noise voltage ***referred to the total RMS value*** is obtained as result, display in % or dB.

LEVEL THDN

The THD including noise is measured, the result is the root from the square sum of the selected harmonic and the noise voltage, display of the rms value (in any level unit).

LEVEL NOISE

The noise is measured, only; the noise is obtained as result, display of the rms value in % or dB.

Dyn Mode

(Dynamic Mode) only in the analog analyzers
Determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with low dynamic is performed.

PRECISION

The measurement is performed with higher dynamic and with the analog notch filter cut in; the measuring time increases, correspondingly.
The notch filter is laid out for measurements up to 22.5 kHz - i.e. there are no restrictions in the ANLG 22-kHz instrument. Signals with a fundamental ≤ 22.5 kHz can be measured in the ANLG 110-kHz instrument. Signals with a fundamental > 22.5 kHz cause the error message "Frequency exceeds notch range" to be output.

The measuring time is longer in the PRECISION mode.

Rejection

Displayed only in the analog instruments with the Dyn Mode FAST.

NARROW

The fundamental is suppressed extremely narrowband. Thus, interference components can be recognized which are very close to the carrier.

WIDE

To suppress the fundamental, a notch filter is used with a characteristic which was in the past commonly used in analog measuring instruments. The measured values are improved due to the broadband filtering, since harmonic components close to the carrier are also suppressed.
This mode should be used if the measurement results are to be comparable to those of analog instruments.

Meas Time

(Measurement time)
The measurement time is used to adapt the measurement speed to the required accuracy. To obtain a higher measurement speed the (initial) FFT size is reduced.

SLOW

Measurements are performed with the greatest FFT size (8k zoom FFT). Additional FFTs (with a higher zoom factor) are only required for extremely low frequencies. This setting should be selected in particular when only the noise (NOISE or LEVEL NOISE) is measured so that harmonics are suppressed with a bandwidth as narrow as possible.

FAST

The initial FFT is measured with reduced FFT size (2 k). With low frequencies, additional FFTs (with more points and a higher zoom factor) are required.

SUPERFAST

The initial FFT is measured with the smallest FFT size (0.5 k). Additional FFTs (with more points and a higher zoom factor) may be required. This setting should only be selected if the measurement result need not be too accurate and the frequency of the signal to be measured is not very low.

Note: *With post-FFT switched on, the FFT size can be set as required irrespective of the settings made here, i.e. the selected measurement speed is ignored.*

Unit

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(See 2.6.5.1 Common Parameters of Analyzer Functions)
only available in level measurement modes (LEV...).

This value may be entered manually if desired. Otherwise, the current RMS value will be automatically entered, if the reference value of INPUT DISP RMS is stored with the STORE (or STORE CH1 or STORE CH2) function.

Fundamental

Determines how to obtain the fundamental frequency.

AUTO

UPL determines the fundamental frequency automatically (while the THD+N measurement is being performed)

VALUE

Numerical entry of fundamental frequency.
Specified range:

ANLG 22 kHz:	10.0 Hz	to	21.9 kHz
ANLG 110 kHz:	20 Hz	to	120 kHz
DIGITAL:	12 * sample freq. /8 * 8192 to sample freq. * 117/256		

The setting VALUE should preferably be used for signals with a high harmonic content when an external generator is used as a signal source.

GEN TRACK

UPL takes the fundamental from the frequency setting of the generator. This increases the setting accuracy for signals with high harmonic content and increases the measurement speed.

If the frequency of a fundamental cannot be measured with the set FFT size, the FFT size is increased such that the measurement can be performed with a single FFT (or 2 FFTs in the precision mode). Thus the highest possible measurement speed can be obtained for any generator frequency with the setting FFT Size 512.

Setting GEN TRACK is to be used when the signal is derived from the internal generator.

Note: *When the internal low-distortion generator is used, the generator frequency is accurately measured in the measurement modes NOISE or LEVEL NOISE and the dynamic mode PRECISION and the fundamental is corrected, if required. Thus the measurement result is not influenced by the frequency inaccuracy of the generator (e.g. temperature drift). This does not affect the measurement speed, however.*

Filter

The THD+N measurement result can be weighted using one of 14 filters (see 2.7.1).

OFF
A weighting
C MESSAGE
CCITT
CCIR wtd
CCIR unwtd
DEEM 50/15
DEEMPH 50
DEEMPH 75
DEEMPH J.17
RUMBLE WTD
RUMBLE UNW
DC NOISE HP
CCIR ARM
IEC TUNER

CCIR unwtd is not available in the ANLG 110-kHz instrument.

FrqLim Low

Lower band limit of THD+N / SINAD measurement function. This limit does *not* influence calculation of the total RMS value.
Specified range:
ANLG 22 kHz: 10.0 Hz to 21.93 kHz
ANLG 110 kHz: 20.0 Hz to (120 kHz - 62.5 Hz)
DIGITAL: sample freq./ (2 * 8192) to (sample freq. * 0.45294)

FrqLim Upp

Upper band limit of THD+N / SINAD measurement function
Specified range:
ANLG 22 kHz: (FrqLim Low + 8.79 Hz) to 21.94 kHz
ANLG 110 kHz: (FrqLim Low + 62.5 Hz) to 120 kHz
DIGITAL: (FrqLim Low + sample freq. / 5461.3) to sample freq. * 117/256

Note: *If the fundamental of the measurement signal is above "FrqLim Upp", relative measurements (THDN, SINAD and NOISE) are not useful because the energy of the fundamental has been filtered out in the reference signal. In this case an error message is output.*

Only harmonic distortions and noise components within the band limits are used in the calculation.

Only frequencies *below FrqLim Upp* are considered in the calculation of the total RMS value.

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

POST FFT

OFF

ON

(see 2.6.5.1 Common Parameters of Analyzer Functions)

There is ***no*** post-processing of measuring data for POST FFT, the measurement can thus be terminated faster.

After obtaining the result of the THD+N measurement, the measured data are prepared for ***POST FFT display***. The display can be selected in the DISPLAY panel. Only FFT Size of the following five FFT setting parameters can be modified, all others are displayed.

Note: *If the selected FFT size is too small, the POST FFT cannot be displayed.*

FFT Size

512
1024
2048
4096
8192

FFT size used for THDN calculation and post-FFT display, adjustable between 512 and 8192 in steps of 2.

A larger FFT size (i.e. more calculated points) yields a finer frequency resolution and thus a lower frequency limit and higher accuracy but longer measurement times.

The FFT size selected determines the display of the post FFT and the original zoom FFT used for THDN calculation. If the FFT size is not sufficient to resolve the fundamental, the following results are obtained has the following consequences:

- The post FFT cannot be displayed; an error message is indicated in the graphics display.
- Additional FFTs with an increased number of points are automatically calculated; the measurement time is extended accordingly.

To be able to perform a *Post* FFT, the fundamental must be above the displayed resolution (see below) by a defined factor. This factor is as follows:

- 12 for (LEVEL) THDN and SINAD in the digital analyzer,
- 10 for (LEVEL) THDN and SINAD in the ANLG 22 kHz analyzer,
- 8,5 for (LEVEL) THDN and SINAD in the ANLG 110 kHz analyzer,
- 36 for all (LEVEL) NOISE measurements.

If required, the FFT size has to be increased or the ANLG 22 kHz instrument has to be selected.

To avoid additional FFTs (because the FFT size is too small) without having to switch to a larger and thus slower FFT, "Fundamental GEN TRACK" should be selected when the internal generator is used. With this setting the fundamental is known before the 1st FFT so that the calculation can be started with the smallest possible FFT (≥ FFT size).

Window

Always RIFE VINC 2 (analog) or RIFE VINC 3 (digital)

Note: *For more specialized applications the parameter "-tthdn" may be used to select the FFT window to be used for the THD+N measurement.*

Start

Display value, not identical with FrqLim Low

Stop

Display value, (useful bandwidth), not identical with FrqLim High

Resolution

The display value determines the lower limit frequency for the measurement.

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Aural monitoring of the residual THD+N signal is described in section 2.6.6 Headphone/Speaker Output; Example of application: Monitoring the distortion component of a signal.

2.6.5.8 MOD DIST (Modulation Distortion)

Available in all analyzers.

For modulation distortion measurements, apply a frequency mixture consisting of a low-frequency interfering sinewave signal (e.g. 60 Hz) and a high-frequency useful sinewave signal (e.g. 7 kHz) to the device under test. The amplitude of the interfering signal should be equal or higher than that of the useful signal. According to DIN IEC 268 Part 3, a peak amplitude ratio of interfering : useful signal = 4 : 1 should preferably be selected.

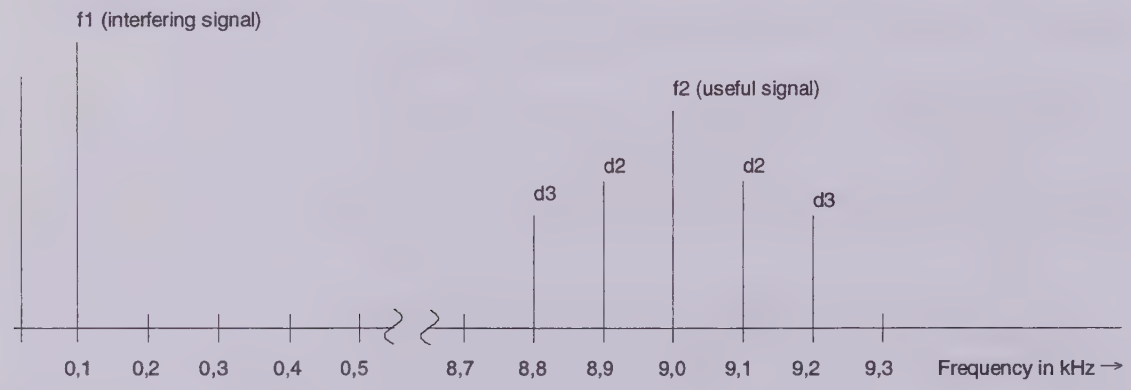
When the signal offered does not meet the requirements, a SHOW I/O message (see 2.5.3) is output:

- Useful signal is not in the frequency range from 2 kHz to 110 kHz:
  "Cannot find high tone in the range from 2 to 110 kHz."
- Interfering signal is not in the frequency range from 0 Hz to 1100 Hz:
  "Cannot find low tone in the range from 0 to 1100 Hz."

With the signal function MOD DIST (see 2.5.4.7), the UPL generator offers by the above frequency mixture, allowing the frequencies and amplitude ratio of interfering and useful signal as well as the level to be specified. Total level and useful frequency can be swept.

Principle of measurement

Unaffected by noise due to selective measurement, the UPL measures the intermodulation products of 2nd and 3rd order in line with DIN IEC 268 Part 3 and does the square sum of the intermodulation products. (Contrary to the DIN IEC 268 Part 3 Recommendation, the total modulation distortion is measured to permit comparisons with the hitherto commonly used SMPTE measurement procedures).



d2 = Intermodulation product of 2nd order
d3 = Intermodulation product of 3rd order

Fig. 2-24

Modulation distortion of 2nd order

$$dm2 = \frac{|U_{(f1+f2)}| + |U_{(f2-f1)}|}{U_{(f2)}}$$

Modulation distortion of 3rd order

$$dm3 = \frac{|U_{(f2-2f1)}| + |U_{(f2+2f1)}|}{U_{(f2)}}$$

Square sum:

$$dm(2+3) = \sqrt{dm2^2 + dm3^2}$$

$$\text{MOD DIST [dB]} = 20 * \lg (dm(2+3))$$

Display of the measurement result:

In addition to displaying the total intermodulation distortion in the result display, an additional graphical (histogram) or numerical display of the useful frequency and the signal frequency and of the individual intermodulation products can be switched on. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

Note: *If the intermodulation signals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

Dyn Mode

(Dynamic Mode), with analog analyzers, only.
Determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with less dynamic is performed.

PRECISION

If the measured value is better than 55 dB (analog 22 kHz) or 40 dB (analog 110 kHz), the measurement is performed with higher dynamic range and analog notch filter cut in. The measuring time increases, correspondingly. If the intermodulation value of the signal drops below 50 to 55 dB, the measurement is performed in FAST mode.

Unit

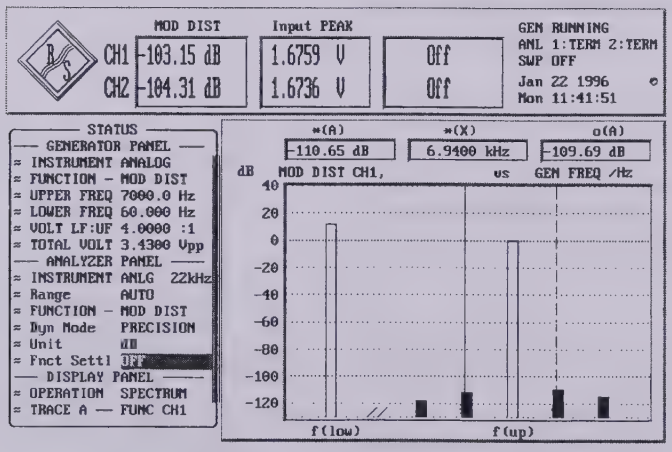
(see 2.6.5.1 Common Parameters of Analyzer Functions)

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)



Graphical presentation of MOD DIST measurement results in the form of a histogram see 2.10.1 and 2.10.2

2.6.5.9 DFD (Difference Frequency Distortion)

Available in all analyzers.

To measure the difference frequency distortion of 2nd or 3rd order, apply a frequency mixture to the device under test. The frequency mixture is to consist of two sinewave signals of the same amplitude with, to DIN IEC 268 part 3, an arithmetic mean frequency out of the one-third octave band (5, 6.3, 8, 10, 12.5, 16, 20 kHz). A frequency offset of 80 Hz is to be selected, preferably.

Frequency limits for d_2- and d_3-measurements:
$2f_2$-f_1 must still be within the frequency range of the instrument set (see 2.6.1).
When the signal offered does not meet the requirements, a SHOW I/O message is output (see 2.3.5):

- The frequency difference is higher than 1100 Hz:
  "Frequency difference of IMD tones seems to be too large; (> 2100.0 Hz)"
- The frequency difference is less than 70 Hz:
  "Frequency difference of IMD tones seems to be too small; (<70.0 Hz)"
- The levels of the two sinewave signals differ by more than 20 %:
  "Level of IMD tones seems to be too different; (more than 20 %)"

Note: *A level check of IMD tones is **not** performed in the measurement modes to **IEC 118**. A DFD measurement can therefore be carried out even in the case of strongly distorted IMD signals (e.g. because of the frequency response of the DUT or the transmission path).*

With the signal function DFD (see 2.5.4.8), the UPL generator offers the above frequency mixture. The mean frequency, frequency difference and total amplitude can be specified by the user.

Principle of measurement

With the Meas Mode d_2 or d_3 selected, the UPL measures selectively. Thus being unaffected by noise, the intermodulation products of 2nd or 3rd order are measured in accordance with DIN IEC 268 part 3.

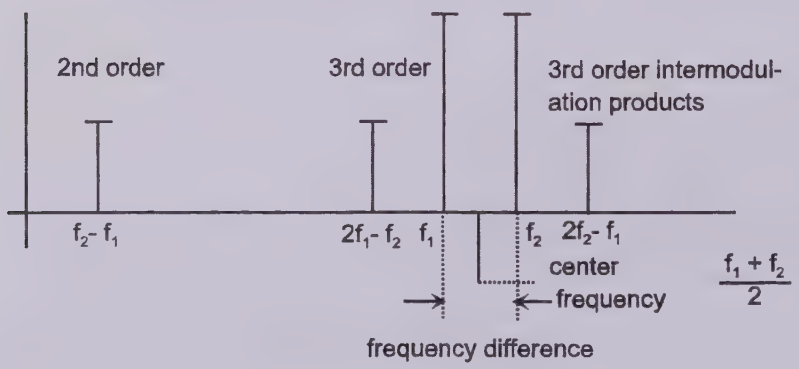


Fig. 2-25

Difference frequency distortion of 2nd order:

$$d_2\,[\mathrm{dB}] = 20 \times \lg \frac{\left|U_{(f_2 - f_1)}\right|}{2 \times U_{(f_2)}}$$

$$d_2\,[dB] = 20x\lg \frac{\left|U_{(f_2 - f_1)}\right|}{U_{(f_2)}}$$

Difference frequency distortion of 3rd order:

$$d_3\,[\mathrm{dB}] = 20 \times \lg \frac{\left|U_{(2f_2 - f_1)}\right| + \left|U_{(2f_1 - f_2)}\right|}{2 \times U_{(f_2)}}$$ to IEC 268

$$d_3\,[dB] = 20x\lg \frac{\left|U_{(2f_1 - f_2)}\right|}{U_{(f_2)}}$$ to IEC 118

Display of measurement result:

In addition to displaying the difference frequency distortion (d2 or d3) in the result display, an additional graphical (histogram) or numerical display of the center frequency and the difference frequency (according to the meas. mode selected) and of the individual intermodulation products can be switched on. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

Note: *If the intermodulation signals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

Meas Mode

Measurement mode for selecting the order of the intermodulation product and the measurement standard used.

d2 (IEC 268)

Measurement and display of 2nd order intermodulation products referred to *twice* the "upper frequency" (to IEC 268).

d3 (IEC 268)

Measurement and display of 3rd order intermodulation products referred to *twice* the "upper frequency" (to IEC 268).

d2 (IEC 118)

Measurement and display of 2nd order intermodulation products referred to the "upper frequency" (to IEC 118).

d3 (IEC 118)

Measurement and display of 3rd order intermodulation products referred to the "upper frequency" (to IEC 118).

Note: *Measurements to IEC 118 are mainly used for hearing aids. Due to the different formulae, the d2 measurement to IEC 268 yields a result better by 6 dB.*

Dyn Mode

Dynamic Mode, only for analog Meas Mode → d2;
determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with less dynamic is performed.

PRECISION

If the measured value is better than 50 dB, the measurement is made with higher dynamic. The measuring time increases, correspondingly. If the intermodulation value of the signal is below 50 dB, the measurement is performed in FAST mode.

Unit

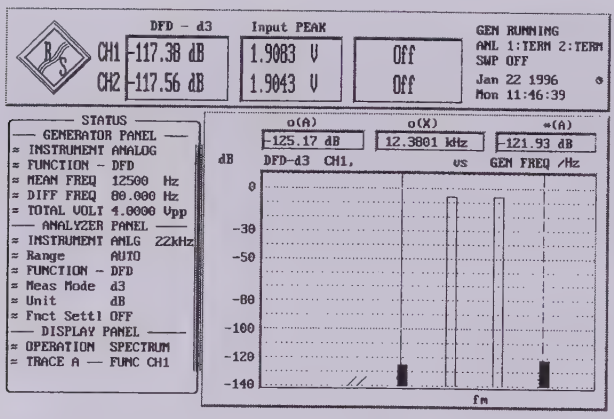
(see 2.6.5.1 Common Parameters of Analyzer Functions)

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)


DFD - d3
Input PEAK
CH1 -117.38 dB
CH2 -117.56 dB
1.9083 V
1.9043 V
Off
Off
GEN RUNNING
ANL 1:TERM 2:TERM
SWP OFF
Jan 22 1996
Mon 11:46:39
STATUS
GENERATOR PANEL
INSTRUMENT ANALOG
FUNCTION - DFD
MEAN FREQ 12500 Hz
DIFF FREQ 80.000 Hz
TOTAL VOLT 4.0000 Vpp
ANALYZER PANEL
INSTRUMENT AMLG 22kHz
Range AUTO
FUNCTION - DFD
Meas Mode d3
Unit dB
Fnct Settl OFF
DISPLAY PANEL
OPERATION SPECTRUM
TRACE A — FUNC CH1
σ(A)
σ(X)
⌀(A)
-125.17 dB
12.3801 kHz
-121.93 dB
dB
DFD-d3 CH1,
vs
GEN FREQ /Hz
0
-30
-50
-80
-100
-120
-140
fm

2.6.5.10 Wow & Flutter

Available only in the instruments ANLG 22 kHz and DIGITAL.
Measurement of the frequency deviation of a recording device (wow & flutter). To this end, a sine tone with fixed frequency (usually 3.15 kHz or 3.00 kHz) is reproduced by a reference sound carrier. During its reproduction, frequency errors occur because of cyclic variations. Frequency distortion is specified in percent of the carrier frequency. These deviations are determined using different weighting filters and methods depending on which standard is applied.

Principle of measurement

The input signal is limited symmetrically to the test frequency (3 kHz to NAB and JIS, 3.15 kHz to DIN) using a bandpass filter (passband width 1000 Hz, attenuation 80 dB, Bessel characteristic), and is subsequently subjected to FM demodulation. The demodulator output is sampled at 1/16 of the original sampling frequency and stored for POST FFT. A higher sampling rate is not useful because the signal is band-limited. Following a bandpass which can be cut in, the respective weighting is selected depending on the standard.

Standard

Set the standard applying to the measurement:

DIN/IEC

Standards:	DIN 45507 / IEC 386 / CCIR 409-2	
Reference frequency:	3150 Hz	
Weighting filters:	weighted:	bandpass, center frequency 4 Hz
	unweighted:	highpass, 0.5 Hz
Weighting method:	quasi-peak,	
	time constants: rising time:	30.8 ms,
	falling time:	606 ms

NAB

Standards:	NAB Rec.	
Reference frequency:	3000 Hz	
Weighting filters:	weighted:	bandpass, center frequency 4 Hz
	unweighted:	highpass, 0.5 Hz
Weighting method:	averaging the detected frequency error signal, time constant: 300 ms	

JIS

Standards:	Japan Industry Standard	
Reference frequency:	3000 Hz	
Weighting filters:	weighted:	bandpass, center frequency 4 Hz
	unweighted:	highpass, 0.5 Hz
Weighting method:	rms weighting, integration time 2 sec	

2 Sigma 5 s
2 Sigma 10 s

The 2-sigma weighting to IEC 386/1988 is implemented in the UPL. Its purpose is to determine a threshold for the wow and flutter value at which 5 % of the measured values have a magnitude that is higher than this threshold, ensuring that sporadically occurring outliers do not affect the measurement result.
The integration time is selectable: 5 or 10 seconds.

Weighting

ON

The measurement is weighted using a weighting filter, bandpass 4 Hz.

OFF

Weighting filter off, highpass 0.5 Hz.
Maximum weighting bandwidth in both cases: 200 Hz

Frequency response of weighting filter (to DIN 45507, IEC 386, CCIR Rec. 409-2):

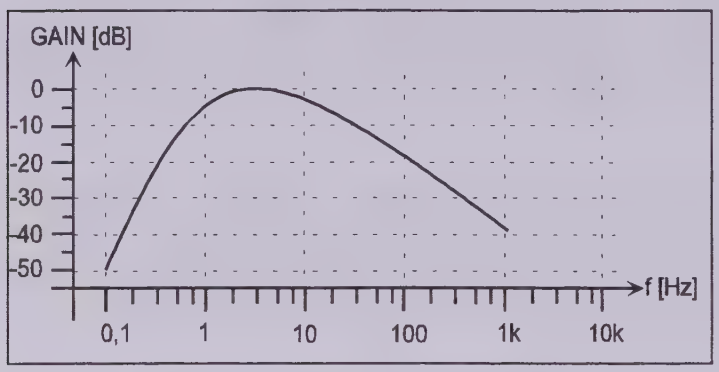


Fig. 2-26 Frequency response of weighting filter

Unit

(cf. 2.6.5.1 Common Parameters of Analyzer Functions)
The W&F measurement result can be indicated in %, only.

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Post FFT

(see 2.6.5.1 Common Parameters of Analyzer Functions)

ON

Display of the frequency spectrum of the data which have been FM-demodulated and weighted with the weighting filter. The wow and flutter measurement is aborted after about 2 seconds with POST FFT selected. The demodulated data are subsequently used for calculation of an FFT.

OFF

No POST FFT (thus no interruption of the measurement).

FFT Size

Enter FFT size (256 to 8192). (see 2.6.5.12 FFT).

Window

Select the window function; possible windows and their applications, see 2.6.5.12 FFT.

Start

Display of the frequency limits of the generated spectrum (no entry). Since the demodulator stage samples by the factor 16, the upper limit of the spectrum is

127/256 * sampling rate / 16

(For sampling rate, cf. 2.6.1 Selecting the Analyzer).

Stop

Resolution

Display of frequency resolution (no editing).

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.11 POLARITY (Polarity Test)

Available in all analyzers.

The POLARITY measurement serves to check whether a device under test passes on an applied signal with the same polarity or with reversed polarity. To this end, set the POLARITY function on the generator (see 2.5.4.11) and apply the generator test signal (SINE^2 BURST signal) to the DUT.

Principle of measurement:

The analyzer weights and displays the polarity of the DUT output signal. In order for the convention

without polarity reversal= "+1 Pol" is displayed
with polarity reversal = " -1 Pol " is displayed

to be true, a ***positive*** SINE^2 BURST signal must be applied to the DUT. The UPL generator provides a suitable signal function (POLARITY) for this purpose.

An external signal can also be applied to the DUT provided that a suitable SINE^2 BURST signal is used.

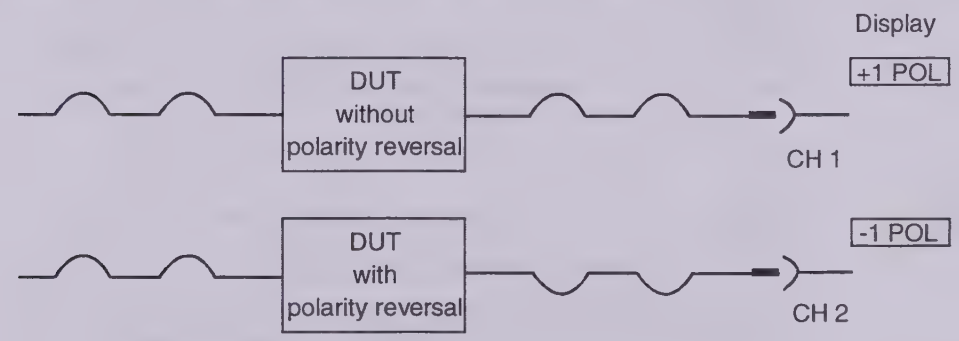


Fig. 2-27

SPEAKER (see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.12 FFT (Spectrum)

Available in all analyzers.

Spectrum display of the unfiltered input signal, transforming into the frequency range being effected by way of the so-called fast Fourier transform (FFT). The graphical or numerical display of the FFT can be selected in the DISPLAY panel (menu item OPERATION). The graphical display is in line with the parameters set in the DISPLAY panel. The section to be displayed (in the x and y directions) can be selected independent of the frequency range and zoomed zone selected in the ANALYZER panel. If, due to inappropriate settings in both panels, a result is outside the visible screen , this can be remedied quickly by selection of the AUTO scaling for the X and the Y-axis (see also 2.10 Graphical Data Presentation (DISPLAY and GRAPHICS Panels)).

Note: *Spectrum display of a **filtered** input signal is possible by way of menu item POST FFT of the function RMS & S/N.*

DC Suppres

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Selectable in the digital analyzer only; corresponding setting for analog analyzers:
"Coupling AC/DC", see 2.6.2 Configuration of the Analog Analyzers

Note: *With DC suppression switched on, the measurement time for FFT is approx. 200 ms longer.*

Unit Ch1/2

Selection of the unit for the display of the RMS value for channel 1 or 2, respectively.
(cf. 2.6.5.1 Common Parameters of Functions)

The selection **entered** here is referred to for display of the spectrum in the DISPLAY panel, as standard. However, it may be overwritten in the DISPLAY panel (by entry under menu item Unit of TRACE A or B).

Reference

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Chan Delay

(Interchannel delay)
Delay compensation of the DUT by entering the time by which channel 1 is to be delayed with respect to channel 2. If channel 2 has a shorter delay than channel 1, this can be compensated for by entering a negative value.
Delay compensation is of relevance to phase measurements, as time discrepancies between the two test signals result in a phase shift dependent on the current frequency, which may corrupt the phase-measurement result.

Specified range: -10 s to +10 s

Note: *If zoom FFT is switched on, interchannel delay cannot be selected; it is set to 0 internally.*

Notch (Gain)

(see 2.6.5.1 Common Parameters of Analyzer Functions)

FFT Size

256
512
1024
2048
4096
8192

FFT size, settable from 256 to 8192 in binary steps.

The larger the FFT size (more calculated points), the better the frequency resolution, however the longer the measuring time. The number of displayable lines as a function of FFT Size and ZOOMing is given below:

Zooming ON:	maximum	FFT Size x 117/256 x 2
Zooming OFF:	analog:	FFT Size x 117/256
	digital:	FFT Size x 127/256

Note: *The number of displayable lines may be reduced with the "Zooming ON" setting - part of the frequency lines may fall within the negative frequency range due to eccentric "Center" setting.*

Window

Selection of the window function:

In system theory, the FFT treats a block of data (finite-length signal sequence) as though it were an infinite periodic sequence. In practice, however, discontinuities usually occur at the ends of the block. The discontinuities would be weighted as pulses (with white spectrum). This pulse spectrum masks the actual (useful) signal spectrum (leakage).
Remedy: The ends of the finite-length signal sequence for the FFT are smoothly tapered to zero by windowing the data. The FFT then treats the signal as a continuous periodic sequence. Window functions thus help to minimize the leakage (at the expense of selectivity).

HANN

Range of applications of the windows:
The HANN window combines selectivity with good leakage suppression for distant interferences, yet has a relatively wide bell-shaped curve around the signal lines.

RECTANGULAR

Window function switched off. When the signal fits exactly with an integer number of periods into the block windowed for the FFT, there will be no discontinuities at the block ends. In this case, a window is not necessary and maximum frequency resolution can be obtained. This characteristic is advantageous for fast and frequency-precise measurements of frequency responses in the case of the generator signals RANDOM / Domain: FRQ (so-called FFT noise, see 2.5.4.9 RANDOM, Domain = Frequency) and MULTISINE (see 2.5.4.4).
(See 2.6.7.3 Fast Frequency Response Measurement)

BLACKMAN-H

The bell-shaped curve falls off very steeply to about 80 dB; however below this point, this window has considerable leakage.

RIFE-VINC 1
RIFE-VINC 2
RIFE-VINC 3

Suppression of distant interferences is excellent with all 3 windows. With increasing order of the windows, the width of the bell-shaped curve decreases at the bottom of the single lines and increases at the top.
Various trade-offs between frequency resolution and suppression of close interferences can thus be made.

HAMMING

Offers no significant advantages, has been implemented for the sake of completeness.

FLAT_TOP

The top of the bell-shaped curve (which is caused only by a single sine line) is as flat as to include always two adjacent lines with approximately the same height.
Advantage: The amplitude can be precisely read from the graphs as against with other window functions.
Disadvantage: Poor frequency selectivity.

KAISER

The trade-off between selectivity, close interference suppression and distant interference suppression determines the selection of parameter ß (from 1.5 to 20). With ß = 8, selectivity is good but distant interference suppression is only about 90 dB. With ß = 16, distant interference suppression is excellent, however the bell is relatively wide.
(see 2.6.5.1 Common Parameters of Analyzer Functions)

Avg Mode

Selection of the averaging method in the FFT

NORMAL

The entered number of FFTs is executed, the partial results added and then divided by this number.
With swept waterfall (OPERATION mode WATERFALL), the waterfall is displayed with respect to all sweeps points.

EXPONENTIAL

Averaging is executed continuously. The current result is calculated to:

$$AVG(n) = \frac{1}{k} \cdot FFT(n) + \frac{k-1}{k} \cdot AVG(n-1)$$

With swept waterfall (OPERATION mode WATERFALL), a waterfall of the intermediate results is displayed for every sweep point; then the waterfall is cleared (for the next sweep point).

Notes: *After a restart of the measurement (e.g. caused by SWEEP, calibration or cursor movement), averaging is started anew. Average is not executed if the display mode is set to MAX HOLD.*

Avg Count

Number of averagings (with Avg Mode NORMAL) or k (Avg Mode EXPONENTIAL, see AVG(n) formula.

Zooming

Determines, whether the FFT is calculated from the entire frequency range or from a section only.

OFF

"Normal" FFT, frequency range from 0 to range limit.
Range limit:
- analog: 117/256 * (internal) sampling rate
- digital: 127/256 * sampling rate.

(For the sampling rates of the individual instruments, refer to 2.6.1 Selecting the Analyzer.)

ON (2...128)

Zoom the frequency range about the center frequency (Center) by processing the signal in the time domain before the FFT (see notes below). Zooming is effected with a factor of 2, 4, 8, ... up to 128 (16 in ANLG 110 kHz). The factor is determined by the span. The measuring time is doubled with each zoom step. The maximum zoom factor depends on the selected instrument (see below).

Zoom Fact

(Read only, can't be changed)
Display of the zoom factor.

Start

(Read only, can't be changed)
Display of the lower measurement limit:
with normal FFT: 0 Hz
with ZOOM-FFT: frequency of the 1st line which lies in *the positive frequency range*

Stop

(Read only, can't be changed)
Display of the upper measurement limit in Hz or kHz
See table 20.

Center

This menu item is displayed only with Zooming ON. Center of the zoomed zone, continuously variable within the useful range of the respective instrument.

With the center frequency set closer to the ***lower*** range limits (0 Hz) than span /2, part of the frequency lines are allotted to the negative frequency range. These lines are ***not*** calculated, they are, however, not available for the frequency resolution.

If the center frequency is set closer to the ***upper*** range limits than span /2, part of the frequency lines exceed the frequency range. These lines contribute to the calculation and are displayed in order to enable evaluation of the behaviours at the range limits. For normal applications, this setting should be avoided, since the measured rms value may become incorrect due to aliasing components.

Span

This menu item is displayed only with Zooming ON. You can select out of 7 (with DIGITAL and ANLG 25) or 4 (with ANLG 110) possible zooming zones. SPAN is the entire range displayed, except for the event that Center was selected such that part of the FFT is below 0 Hz (see Center). The selection list for span is calculated depending on the current sampling rate and labeled.

Resolution

(Read only, can't be changed)
Spacings between the FFT lines in Hz or kHz. Line spacings down to the mHz range can be obtained by selecting a high zoom factor (very small span) and a long FFT (large FFT size).

Specified range:
normal FFT

ANLG 22 kHz	5.8598 x 8192 / FFT Size
ANLG 110 kHz	37.5 x 8192 / FFT Size
DIGITAL	sample frq / FFT Size

Zoom FFT:
Value of the normal FFT /zoom factor

Meas Time

(Measurement Time)
(Read only, can't be changed)
Time required by the analyzer for signal

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Table 2-31: Upper range limit for the FFT as a function of the analyzer instrument and zooming

Instrument	upper range limit for FFT	
	with normal FFT	with Zoom-FFT (depending on "Center"; maximum)
ANLG 22 kHz	21.938 kHz	21.938 kHz
ANLG 110 kHz	12o kHz	120 kHz
DIGITAL	127/256 * Sample Frq	117/256 * Sample Frq

***Note**: The antialiasing filter in the analyzer ANLG 110 kHz is effective before reaching the upper range limit, already*

Additional information on FFT:
Width of bell-shaped curve (worst case) in lines:

Table 2-32 FFT window

Window	-20 dB	-40 dB	-60 dB	-80 dB	-100 dB
Hann	4	7	14.5	29	64
Rectangular	6.7	68	∞	∞	∞
Blackman-Harris	4.5	6	7	8	21.5
Rife-Vinc 1	4	6	9	14	21
Rife-Vinc 2	5.5	7	9	11	16
Rife-Vinc 3	6.5	8.2	10	12	14,5
Hamming	3	4	29	∞	∞
Flat_Top	7.5	9	11	14	19
Kaiser (ß=8)	3.5	4.2	6	11.5	
Kaiser (ß=16)	4.5	6	8	11	15

∞ this suppression will never be attained or far off only.

Frequency measurement with FFT: With FFT, the spectral line with the highest signal amplitude in the with FFT: spectrum is entered as frequency value in the respective display field. With the exception of the Kaiser window, the adjacent lines are included as part of the frequency calculation, thus increasing the accuracy (on the assumption of single sine lines). In particular with the windows HANN, RIFE VINC 1 to 3, high accuracies can be obtained.

Amplitude accuracy: Depending on the window and position of the single signal lines relative to the FFT lines, system-related display read errors of up to -3 dB occur. The error is worst when the selected window is narrow at its top, the input signal falling on the center between two FFT lines (e.g. in rectangular windows).
Using the cursor function IMAX (interpolated maximum) for reading the peak values in the display causes the interpolation to be made on the actual peak value, the windows HANN, RIFE-VINC 1-3 providing accuracies of more than 1 % (on the assumption of single sine lines, only).

Implementing the FFT: The FFT has been implemented as decimation-in-frequency-FFT in complex presentation with 32-bit floating numbers. For coding, in particular the rounding noise has been optimized, reducing the errors due to FFT processing to less than -130 dB. The data are input to the analyzer at a time, the FFT being computed subsequently. Thus, the measurement is not continuous, which does however not adversely affect the measurement (with usually stationary signals).
With ZOOM-FFT, the input signal is shifted by way of convolution with a Dirac pulse at the center frequency so that the selected range falls on frequency values around zero. After lowpass filtering and subsequent undersampling, the range can be displayed with a better resolution.
A ZOOM is always implemented in three stages (up to the factor of 8). Zooming up to the factor 256 is feasible when using the "slow" instruments ANLG 22 kHz and DIGITAL. The input signal for the FFT will be complex when shifting the input signal using a single Dirac pulse. For this reason, 7488 (analog) or 4064 (digital, without zoom) points are displayable with an FFT of 8192 points! With ZOOM, the center frequency is visible in the display at about -140 dB (on technical grounds).

Resolution, measurement time and span

Example: ANLG 22 kHz and DIGITAL: (sampling rate = 48 kHz, 8192 FFT points)

Table 2-33 Resolution, measurement time and span with FFT

	max. SPAN [Hz]	max. resolution [Hz]	Measurement time [ms]
FFT	23807	5.8593	170.71
ZOOM 2:1	21938	2.9296	348.12
ZOOM 4:1	10969	1.4648	696.25
ZOOM 8:1	5485	0.7324	1392.5
ZOOM 16:1	2742	0.3662	2785
ZOOM 32:1	1371	0.1831	5570
ZOOM 64:1	686	0.0915	11140
ZOOM 128:1	343	0.0457	22280

SPAN and resolution are proportional to, measuring time is reciprocal to the sampling rate.

Window functions:

All window functions (except for Kaiser) are computed according to the following formula:

$$Window(i) = \sum A(n)\ x\ cos\left(\frac{2\pi ni}{FFT-Size}\right)$$

where A(n) is the respective amplitude factor of line n.

Table 2-34 Window functions with FFT, Coefficients A(n)

	A(0)	A(1)	A(2)	A(3)	A(4)
HANN	0.50000	-0.50000	0.0	0.0	0.0
RIFE-VINC 1	0.37500	-0.50000	0.12500	0.0	0.0
RIFE-VINC 2	0.31250	-0.46875	0.18750	-0.03125	0.0
RIFE-VINC 3	0.2734375	-0.43750	0.21875	-0.06250	0.0078125
BLACKMAN-H	0.35875	-0.48829	0.14128	-0.01168	0.0
HAMMING	0.54000	-0.46000	0.0	0.0	0.0
FLAT–TOP	0.18810	-0.36923	0.28702	-0.13077	0.02488
RECT	1.00000	0.0	0.0	0.0	0.0

The KAISER window is given by:

$$Window(i) = \frac{BESSEL(\beta * \sqrt{1 - \frac{4n^2}{N^2}})}{BESSEL(\beta)}$$

where BESSEL (i) is the modified Bessel function of 1st order.

2.6.5.13 FILTER SIM

Available in all analyzers.
The function FILTER SIM. is not used for measurements, but serves to check a selectable combination of filters or user-defined filters for their sum frequency response. For this purpose, filters can be selected as with the functions RMS, PEAK and QUASI-PEAK.

The filter simulation takes place with a fixed pattern in the frequency domain. This pattern results in system clock /8192; (e.g. a sampling rate of 48 kHz results in 5.86 Hz). The range from 0 Hz to half the sampling rate is simulated, producing 4096 output points in the graphics.

Functioning of the simulation:

The filters used in the UPL are IIR (infinite impulse response) filters. These filters are defined by poles and zeroes in the complex Z-level, conjugated complex poles and zeroes being combined to a real biquad.

These biquads feature the following transfer function:

$$H(z) = b0 \times \frac{z^2 + b_1 z + b_2}{z^2 - a_1 z - a_2}$$

4 biquads constitute an UPL filter, the coefficients b0 of the single biquads being multiplied so that a common gain is obtained. Up to 4 of such 8-pole UPL filters can be used in measurement functions.

This sum transfer function (sum of all single transfer functions) is evaluated for

z = exp(jw) with w = (0 toi * π/ 4096) and i = 0 to 4096

the denominator and numerator polynomials and the filter gain being calculated at the simulation points. Hence, the filter simulation features only a fixed resolution, extremely sharp filters (e.g. very narrow-band notch filters) cannot be simulated in this way. Actually, such filters should not be used at all, because, in the case of pole and zero positions near the unit circle, numerical accuracy problems occur or these filters have a tendency to show so-called limit cycles (i.e. signals at the filter output without a corresponding signal at the filter input).

The above frequency pattern does not apply to the use of the filters in measurements (RMS, PEAK, QUASI-PEAK), since the filters are calculated in the time domain in this case.

Filter	(see 2.7 Analyzer Filters (FILTER Panel)) Up to 3 filters can be simulated.
SPEAKER	(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.14 Waveform (Display in the Time Domain)

Available in all analyzers.
This function is used to display the input signal in the time domain. The trigger state being displayed in the result window, the signal in the graphics window. Level values can be read from the graphics window using the cursors. A filter selection can be made similar to the functions RMS, PEAK and QUASI PEAK.

Two-channel measurement:

In the slow instruments, (ANLG 22 kHz and DIGITAL), the two input signals are measured simultaneously. One of them may be selected as trigger channel. As soon as it has exceeded the trigger level, the two channels are triggered such that they are graphically displayed with correct time.
In the fast (analog) analyzer, the two channels are measured sequentially, which is why no time reference between the two channels is specified.

Triggering:

The UPL waits for the specified slope at the defined level. In case this condition does not occur within double the memory depth, automatic triggering is set off. This is indicated by "not triggered".
In the slow analyzers, both channels have the same time axis, which is relative to the trigger point of the selected trigger channel.
In the fast analyzer, the time axis of each (individual) channel is relative to the trigger point of the selected channel.

Settings:

In the ANALYZER panel only the trigger condition and the memory depth and, with slow analyzers, also the trigger channel are set. Scaling of the picture (X and Y axis) is set in the DISPLAY panel (see Section 2.10).

DC Suppres

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Selectable in the digital analyzer only;
corresponding setting for analog analyzers:
"Coupling AC/DC", see 2.6.2 Configuration of the Analog Analyzers

Note: *With DC suppression switched on, the time required for each measurement is approx. 200 ms longer.*

Meas Mode

Determines the memory depth and processing mode

STANDARD

Usual display of the samples, max. TRACE length is 7488 samples.
For smoothing of the curve display (with periodic signals), the "Interpol" measurement mode can be switched on.
Recommended for short recording and with periodic signals.

COMPRESSED

Only for the analyzers ANLG 22 kHz and DIGITAL.
In the COMPRESSED mode, the input signal is first fed to a peak-value detector (absolute value generation). Following this, the number of samples set under Comp Fact are combined. This peak value is then used as the input signal of the waveform function. Thus the x-axis is so to speak compressed, which allows long times to be acquired.
Interpol can't be switched on.
Recommended if ***long*** recording times are required and only the ***peak value characteristic*** is of interest.

Note: *When settings are made in the display panel, the compressed WAVEFORM can also be logarithmically displayed. This can be either directly specified (Spacing LOG) or indirectly by selecting a logarithmic unit. Power units (e.g. W, %P/P_r) may also be used.*

Application: *Investigation of switch-on/off transients, e.g. of AGC circuits (automatic gain control)*

UNDERSAMPLE

For ANLG 22 kHz and DIGITAL analyzers only.
The input signal is "undersampled", i.e. the samples specified under Comp Fact are arithmetically averaged and then used as input sample for the waveform function. As a result the X axis is compressed similar to the compressed mode and long periods can be recorded.
"Interpol" cannot be switched on.
Recommended if ***long*** recording times are required and the ***time template of the signal*** is of interest.

Comp Fact

(Only for Meas Mode COMPRESSED or UNDERSAMPLE)

Selection of the compression ratio for the compressed waveform display. Number of samples which are comprised to one sample for the waveform.

Specified range 2 to 1024

Unit

Selecting the unit for waveform display.
(see 2.6.5.1 Common Parameters of Analyzer Functions)

The unit ***entered*** here is also used as standard for the waveform display in the DISPLAY panel. However, it can be overwritten in the DISPLAY panel (by an entry made under the menu item Unit of TRACE A or B).

Note: *Contrary to an entry in the DISPLAY panel, the unit entered here is stored when the function or instrument is changed making it available again when the function is switched back to waveform display.*

Selectable analog units (applies also to Meas Mode COMMON/INP in the DIGITAL instrument):
V | dBV | dBu | dBm | W | Δ%V| ΔV | V/V_r | %V/V_r | Δ%W |ΔW | P/P_r | %P | P_r | dB_r

Selectable digital units (Meas Mode AUDIO DATA):
FS | %FS | dBFS | Δ% | dB_r | LSBs | bits

Selectable jitter units (Meas Mode JITTER/PHAS):
UI | %UI | dBUI | ppm | ns | UI_r | dB_r

Note: Logarithmic units are only possible in the Meas Mode COMPRESSED.

Ref Volt

(see 2.6.5.1 Common Parameters of Analyzer Functions)
In the case of waveform display the reference value can only be entered as a numeric value; this menu item corresponds to the value entered under „Reference VALUE“.

Filter

One filter each can be selected in the ANLG 22 kHz and DIGITAL analyzers under Source Mode AUDIO DATA.

Trig Level

Set the trigger threshold. The threshold is entered as a fixed voltage, i.e. independent of the measurement range (which is set either fixed or using AUTO RANGE).

Specified range:

digital (audio data mode):	± 1 FS
digital (jitter mode):	± 10 UI
analog and digital common mode:	± 200 V

Trig Slope

Specifies the edge to which should be triggered.

RISING

Rising edge

FALLING

Falling edge

Interpol

(Only Meas Mode STANDARD)
Selects the number of interpolation steps used for the display of the traced waveform.

1

No interpolation

2
4
8
16
32

Interpol > 1 causes switch-on of the interpolation algorithm
This setting can be used to obtain a smoothed display in the case of few samples per period of the input signal. The maximum permissible trace length is however reduced with this setting.
Recommended with high frequencies, which allow for recording of few samples per period, only.

Trace Len

The maximum settable Trace Len is a function of the sampling rate, the interpolation value and the selected measurement mode.

Specified range: 1 µs to max. Trace Len

The following is true:

$$\text{max. Trace Len} = \frac{\text{sampling rate x Comp Fact}}{\text{sampling rate x Interpol}}$$

The memory depth is 7488 samples.

Trig Src

(Trigger channel);
only provided in analyzers ANLG 22 kHz and DIGITAL.

Selects the source which has to trigger recording when the trigger level is exceeded. Both measurement channels - designated "coupled" in the result window - are started synchronously so that the graphical display of the two channels is made with correct time reference.

CHAN 1

Channel 1 triggers the measurement; if channel 2 is also measured, "coupled" is displayed in the result window.

CHAN 2

Channel 2 triggers the measurement; if channel 1 is also measured, "coupled" is displayed in the result window.

GEN BURST

The generator signal triggers the measurement upon the beginning of the "Burst On" phase, provided that a suitable generator function has been selected. This setting ensures that the measurement is started exactly synchronous with the generator burst; internal signal delay times are automatically taken into account. By selecting GEN BURST it is thus possible to determine from the waveform display the signal delay times of DUTs in graphical form.

Note: *Switching over from one-channel to two-channel measurement causes the channel which has been* ***measured last*** *to become the trigger channel.*

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.15 Protocol Analysis

This measurement function is only available with option UPL-B21 (Digital Audio Protocol) installed.

The protocol function is no conventional measurement function but allows for display of the channel status and user data for the AES/EBU interface. The setting is made in the DISPLAY panel (cf. 2.10.8).

2.6.5.16 Measurement of Digital Input Amplitude

In the UPL the measurement of the digital input amplitude is not selected as a measurement function but as an input display (INPUT DISP). To do so the measurement mode COMMON/INP has to be set (see 2.6.5.18 INPUT).
This has the advantage that the input amplitude can be indicated *simultaneously* with the display of the common measurement function.

2.6.5.17 Measurement of Phase between Digital Input and Reference Signal

In the UPL the phase measurement between DIG IN and REF IN is not selected as a measurement function but as an input display (INPUT/PHAS). To do so the measurement mode JITTER/PHASE has to be set (see 2.6.5.18 INPUT).
This has the advantage that the phase is displayed *simultaneously* with the measured jitter value.

2.6.5.18 INPUT Display

Available in all three analyzers.

INPUT DISP

Not provided in the digital analyzer in Meas Mode JITTER/PHAS.

OFF

Input display switched off

PEAK

Display of the input peak value as a numeric value
In the **digital analyzer,** the input signal is sampled with the rate specified by the user (see 2.6.3).
In the **analog analyzers,** the input signal is, after the input level stage, sampled with the following sample rates:

- ANLG 22 kHz with 48 kHz
- ANLG 110 kHz with 307.2 kHz

The input peak measurements mainly serve for checking the maximum input, indicating the peak values of the AC-coupled input signal before the filters.

Exception: *With the analog notch filter switched on in the analog measurement functions RMS, RMS SELECT, QPEAK or FFT, the input peak value is detected after the notch filter.*

RMS

Display of the analog RMS value. Only provided in the analog analyzers and only effective with the measurement functions THD, TDH+N/SINAD, MODDIST, DFD and FFT; can also be displayed as sweep curve (DISPLAY - TRACE A → INP RMS CH1/2).

DIG INP AMP

Provided *only* with Jitter option (UPL-B22) in Meas Mode COMMON/INP.
Display of digital input amplitude at selected digital input (XLR or BNC) This measurement can be performed simultaneously with any measurement function of the COMMON signal.

INPUT/PHAS

Provided *only* with Jitter option (UPL-B22) in Meas Mode JITTER/PHAS.

OFF

Input display switched off.

PEAK

Display of input peak value (see INPUT DISP).

PHAS TO REF

Display of the frame phase of the jittered signal between AUDIO and REF input. This measurement can be performed simultaneously with any measurement function of the JITTER signal.

INPUT DISP → PEAK or RMS

Unit Ch1/2 (see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference (see 2.6.5.1 Common Parameters of Analyzer Functions)

INPUT DISP → DIG INP AMP

Unit Ch1/2 (see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference (see 2.6.5.1 Common Parameters of Analyzer Functions)

DIG OUT AMP

The measured value is referenced to the digital signal level set in the digital generator, i.e. to
- Unbal Vpp, if the UNBAL input is selected,
- Bal Vpp, if the BAL input is selected.

INPUT/PHAS → PHAS TO REF

Unit Ch1/2 Units: UI | %FRM | ºFRM | ns

Since no relative units are used, a reference command is not offered.

2.6.5.19 Frequency Measurement

With the menu item FREQ/PHASE, which is part of the superordinate functions of the ANALYZER panel, five measurement modes can be selected:

OFF	No frequency measurement, therefore faster function measurement
FREQ	Frequency measurement on both channels
FREQ&PHASE	Frequency measurement on channel 1, phase measurement between channel 2 and 1
FREQ&GRPDEL	Frequency measurement on channel 2, measurement of group-delay or continuous phase between channel 2 and 1
SAMPLE FREQ	Display of input sampling frequency (on both channels)

Table 2-35 Frequency measurement

Instrument	Functions in combination with frequency measurement																
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD+N	MOD DIST	DFD	Wow &FL	FFT	Polarity	Filter simul	Coher	Rub&Buzz	1/3-Octave	WAVE-FORM
ANLG 22 kHz	√	√	n	n	n	√	√	n	n	n	√	n	n	n	√	n	n
ANLG 110 kHz	√	√	-	-	n	√	√	n-	n	-	√	n	n	-	√	-	n
DIGITAL	√	√	n	n	n	√	√	n	n	n	√	n	n	n	-	n	n

√ valid frequency-measurement result
\- function measurement not possible (function not available in this instrument)
n no frequency measurement result possible or useful (Display "-----")

The measuring time cannot be selected for the frequency measurement; if possible, the frequency information is obtained by the selected function measurement using various methods:

1. With the two RMS measurements (without POST FFT), it is derived from the number of zero crossings.
2. With other measurements (even OFF function) it is derived from the FFT.

The 1st procedure offers the advantage of high measuring speed, while the 2nd method supplies accurate measured values even with very poor signal-to-noise ratio and/or high frequencies. Thus, the user may optimize frequency measurement for his test signal by selecting the appropriate function - unless a specified function has to be measured, simultaneously:

1. RMS function (without POST FFT) for signals with high signal-to-noise ratio with low to medium frequencies.
2. FFT function or RMS with POST FFT or Function OFF for signals with low signal-to-noise ratio and without low frequencies.

The RMS function allows for increasing the accuracy of frequency measurement by switching on the POST FFT. With POST FFT switched on the frequency measurement result is derived from the FFT if the frequency drops below a lower cut-off frequency - irrespective of an optional spectrum display (menu item "OPERATION" in the DISPLAY panel). This lower cut-off frequency of the FFT is 4 times the FFT resolution and can thus be modified by the user via the FFT size (see 2.6.5.2 RMS).

The measuring accuracy of ***the FFT-based frequency measurement*** depends on the following parameters

- *Window function:* The RIFE VINCent windows 1 or 2 are suited best.
- *FFT-Size*: as high as possible, best 8192

- *Zoom-FFT*: although switching on Zoom-FFT increases the measuring time (just like a big FFT size), the resolution and accuracy are improved (particularly with low frequencies).
- *Zoom factor*: set by selection of "Span". The smaller the span, the larger the zoom factor and the better the frequency resolution and accuracy.
  Note: "Span" and "Center" must be selected such that the desired measurement range from Start to Stop is covered.
  Recommendation: Excellent measurement accuracy can already be obtained with a zoom factor of 2 without the need for limiting the frequency range of the instrument. To this end, "Center" must be set to "Span / 2".

Example: Configure the FFT as indicated below in the measuring range ANLG 22 kHz:

FFT Size	8192
Window	RIFE VINC 2
Avg Count	1
Zooming	ON (2 to 128)
Center	11.975 kHz
Span	21.94 kHz

Thus, measurement range and resolution are obtained:

Zoom Factor	2
Start	6.25 Hz
Stop	21.938 kHz
Resolution	2.9297 Hz

Note: *With Function OFF, the frequency measurement is performed according to the FFT settings described in the example.*

Meas Time

Definition of measurement time and precision of the frequency measurement for the measurement functions OFF and RMS. Does not influence the other measurement functions.

FAST

The frequency measurement (for the measurement function OFF also the phase measurement) is set to attain optimum speed:

RMS: The measurement may be performed without post FFT; the frequency is determined on the basis of the number of zero crossings, unless the user actually switches on post FFT.

OFF: The measurement is performed at reduced FFT size (4 k FFT) and without zooming, which makes it around four times faster than the PRECISION measurement.

PRECISION

The frequency measurement (for the measurement function OFF also the phase measurement) is set to attain optimum precision:

RMS: Post FFT (8 k FFT, without zoom) is switched on automatically to obtain a more precise measurement result.

OFF: The measurement is performed at maximum FFT size and with zoom (factor 2) switched on. For low frequencies an additional measurement is performed using an increased zom factor.

Unit Ch1/2

Selection of the result units for channel 1/2.

With frequency measurement, the (display) units for both channels can be selected individually, in order to display one channel as absolute quantity and the other one with any reference, by way of example.

Selectable units:

Hz | ΔHz | Δ%Hz | Toct | Oct | Dec | f/f_r

Refer to Section 2.4 Units, for conversion formulae and the notation of the measurement result display for IEC/IEEE-bus control.

Ref Freq

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Freq Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.20 Combined Frequency, Phase and Group Delay Measurement

Only for the analyzers ANLG 22 kHz and DIGITAL in two-channel mode
(Channel(s) 1&2 | 1≡2 | 2≡1 | BOTH)

Table 2-36 Availability of phase/group-delay measurement

Instrument	Functions in combination with phase measurement																
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD+N	MOD DIST	DFD	Wow &FL	FFT	Polarity	Filter simul	Coher	Rub&Buzz	1/3-Octave	WAVE-FORM
ANLG 22 kHz	√	n	n	n	n	n	√	n	n	n	√	n	n	n	n	n	n
ANLG 110 kHz	n	n	-	-	n	n	n	n	n	-	n	n	n	-	n	-	n
DIGITAL	√	n	n	n	n	n	√	n	n	n	√	n	n	n	-	n	n

√ valid result of phase and group-delay measurement
- function measurement not possible (function not available in this instrument
n no result of phase or group-delay measurement possible or useful (display "-----")

The phase difference is obtained in the phase measurement from the signals of channels 1 and 2. The phase-measurement results are in the 0 to 360° and -180 to +180° ranges. With frequency sweep running, however, the phase may be continuously measured, ie outside the 360° and -180° limits (continuous phase measurement), provided certain conditions are fulfilled (see group-delay measurement).
For continuous phase measurement select GROUP DELAY and a phase unit.

The signal of channel 1 is used as reference signal.

Note: *The result of the phase measurement is derived from the FFT or POST FFT. If phase or group-delay measurements are performed in conjunction with RMS function, switch-on of the POST FFT is forced, therefore; the frequency-measurement result is derived from the POST FFT, also, provided that the frequency is above the lower cut-off frequency of the FFT (4-fold resolution due to bell-shaped DC offset). The POST FFT may be displayed as spectrum but this is not a must (menu item OPERATION in the DISPLAY panel).*

For ***group delay measurements,*** the phase is differentiated with respect to the frequency, ie the differential quotient is evaluated:

$$\tau_2 = \Delta\varphi / (2\pi \times \Delta f) \qquad \Delta\varphi = \varphi_{2meas} - \varphi_{1meas}$$

For ***continuous phase measurements,*** the difference of two consecutive phase-measurement results is added to the first phase-measurement result:

$$\varphi_2 = \Delta\varphi + \varphi_1 \qquad \Delta\varphi = \varphi_{2meas} - \varphi_{1meas}$$

Both measurements are available in the GROUP DELAY menu item. They are only defined for *changes* in the frequency and therefore only make sense in conjunction with frequency sweeping. If they are attempted at a constant frequency, an error message will be issued.

If a frequency sweep is to be set for measuring group delay or continuous phase, the following should be noted:
- Select the frequency step size and/or the number of sweep points such that phase shifts exceeding 180° between 2 subsequent sweep points cannot occur.

- Spacing should be linear, since, with logarithmic spacing, the frequency increments could be too small with low frequencies and the phase shift could be too large with high frequencies.

When measuring the group-delay versus frequency (e.g., by means of a generator frequency sweep), the first sweep point is not defined, respectively, since a reference point for calculation of the delta values of frequency and phase is not available before obtaining the 2nd frequency value.

Unit Ch1/2

Selection of units for the measurement for channel 1 and 2.

Selectable units for the frequency measurement (channel 1):
Hz | ΔHz | Δ%Hz | Toct | Oct | Dec | f/f_r

Selectable units for the phase measurement (channel 2):
° | RAD | Δ° | ΔRAD

Selectable units for group-delay measurement (channel 2):
s | Δs

Note: *Continuous phase is obtained by selecting ° or* RAD *under GROUP DELAY.*

Refer to section 2.4, Units, for conversion formulae and notation of the measurement result display units for IEC/IEEE-bus control

Ref Freq

(See 2.6.5.1 Common Parameters of Analyzer Functions)

Format Pha

(Format phase) Displayed range of phase values:

0 ... 360°	from 0 to 360°; selectable, if UNIT CH2 ° | Δ°
-180 ... + 180°	from -180° to +180°; selectable, if UNIT CH2 ° | Δ°
-360 ... 0°	from -360 to 0°; selectable, if UNIT CH2 °|Δ°
0 ... 2 Π	from 0 to 2π; selectable, if UNIT CH2 RAD | ΔRAD
-Π ... +Π	-π to +π ; selectable, if UNIT CH2 RAD | ΔRAD
-2 Π ... 0	from -2π to 0; selectable, if UNIT CH2 RAD | ΔRAD

Note: *Continuous phase representation (-∞ to +∞) is possible under GROUP DELAY if a phase unit is selected instead of the usual time unit.*

Ref Phase

(See 2.6.5.1 Common Parameters of Analyzer Functions)

Freq Settl

(See 2.6.5.1 Common Parameters of Analyzer Functions)

Phas Settl

(See 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.21 Measurement and display of analyzer sampling frequency

Only available in the digital analyzer.

When selecting SAMPLE FREQ, the measured sampling frequency is displayed on the channels switched on (or in the frequency window of the JITTER/PHAS or COMMON MODE measurement). Irrespective of the selection of menu item FREQ/PHASE, the sampling frequency is always measured internally and can also be displayed in the PROTOCOL panel (provided that option UPL-B21 is fitted).

Unit Ch1/2

Selection of the result units for channel 1 and 2.

Selectable units for the sampling rate:
Hz | ΔHz | Δ%Hz | Toct | Oct | Dec | f/f_r

Refer to Section 2.4 Units for conversion formulae and notation of the measurement result display units for the IEC/IEEE-bus control.

Ref Freq

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Freq Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.22 Coherence Measurement and Transfer Function

This function can only be selected with built-in option UPL-B6 (Extended Analysis Functions).
It is limited to the DIGITAL and ANLG 22 kHz instruments.

The analyzer calculates the transfer function CH1/CH2 (Trace A) and the coherence function (similarity, Trace B) of two signals. In the DISPLAY panel graphical or numerical display of the coherence can be switched on (under menu item OPERATION). The graphics display is in accordance with the parameters set in the DISPLAY panel. The section to be displayed (X and Y direction) can be selected independent of the frequency range selected in the ANALYZER panel.

Measurement method:

The complex FFT is calculated for each channel, the two channels being measured at exactly the same time. The cross-correlation between the two FFTs is formed and averaged. The square of the cross-correlation is divided by the averaged size of the individual FFTs; the coherence result is thus independent of the selected measurement ranges.

$$\gamma^2 = \frac{\left|\sum \text{Kanal1} \otimes \text{Kanal2}\right|}{\sum\left|\text{FFT(Kanal1)}\right| \cdot \sum\left|\text{FFT(Kanal2)}\right|} \qquad \text{where} \quad 0 \le \gamma^2 \le 1$$

$\gamma^2 = 1$ means that at this frequency channel 2 is linearly dependent on channel 1. The accuracy of the measurement increases with the number of averaging performed.

The transfer function is calculated as follows:

$$H(z) = \frac{\sum \left|FFT(Kanal1)\right|}{\sum\left|FFT(Kanal2)\right|}$$

relevant standard: ANSI S3.42-1992

Application:

The coherence measurement function uses test signals which cover the entire audio spectrum; it is therefore recommended to set the generator to noise (both in terms of time and frequency).
The generator signal should be applied simultaneously to the input of the DUT and the analyzer channel 2 (reference channel). The output of the DUT is connected to analyzer channel 1 (measurement channel).

Note: *The coherence measurement performs complex calculations and requires synchronous two-channel input signals. This brings about some limitations:*

- *The coherence function is only available for the instruments DIGITAL and ANLG 22kHz.*
- *Since the coherence measurement is a comparative measurement between channel 1 and channel 2, both channels must be active.*

In contrast to other measurements, no test result is computed in this case but two permanently assigned curves are drawn which can only be stored and loaded together (as "DUAL FILE" in the DISPLAY panel.

- Trace A (menu item FUNC CH1): transfer function CH1/CH2
- Trace B (menu item FUNC CH2): coherence result γ^2

The number of averagings performed *n* is displayed in relation to the number of averagings desired *m*.

averaging n of m

Unit

Selects the display unit for the transfer function; % or dB can be selected.

The selected unit is also used as standard for the spectrum in the DISPLAY panel, but it can be overwritten by an entry in the menu item "Unit" of TRACE A in the DISPLAY panel.

Chan Delay

(Interchannel delay)
Delay compensation of the DUT by entering the time by which channel 1 is to be delayed with respect to channel 2. If channel 2 has a shorter delay than channel 1, this can be compensated for by entering a negative value.

Specified range: -10 s to +10 s

FFT Size

Size of FFT, settable in steps of 2 between 256 and 8192.

A larger FFT size (i.e. more calculated points) implies a finer frequency resolution but also correspondingly longer measurement times.

- 256
- 512
- 1024
- 2048
- 4096
- 8192

Window

Selects the window function

Same as with FFT

- HANN
- RECTANGULAR
- BLACKMAN-H
- RIFE-VINC 1
- RIFE-VINC 2
- RIFE-VINC 3
- HAMMING
- FLAT TOP
- KAISER

Avg Count

Number of averaging operations; the coherence function requires a great number of averaging procedures to obtain accurate results. Averaging numbers above 30 are recommended.

Start

(Display only, no changes possible)
Display of lower measurement limit in Hz or kHz; since no zoom FFT is to be performed here, the lower limit is always 0 Hz.

Stop

(Display only; no changes possible)
Display of upper measurement limit in Hz or kHz.

Resolution

(Display only; no changes possible)
Display of spacing between FFT lines in Hz or kHz.
Specified range: 5.8598 × 8192 / FFT Size

Note: *A normalization factor can be entered for Trace A (transfer function) in the DISPLAY panel (or transferred from the cursor position). Thus the transfer function can be set to 0 dB at any position.*

2.6.5.23 Loudspeaker Measurements (RUB & BUZZ)

This item can only be selected with built-in option UPL-B6 (extended analysis functions) and is offered in the analog analyzers only.

Loudspeaker measurements can only be performed with the internal universal sinewave generator. When the RUB & BUZZ item is selected, suitable ***generator*** setting is automatically performed, if applicable.

INSTRUMENT	ANALOG
FUNCTION	SINE
Low Dist	OFF

Loudspeaker measurements are made up of different measurements some of which can be performed simultaneously. Measurements performed:

- **RUB & BUZZ measurement** with fixed or tracking highpass filter or a combination of the two,
- *simultaneous* **frequency response measurement,**
- **polarity measurement** of the loudspeaker at the end of a sweep or single measurement.

Connecting the test equipment:

The UPL generator is connected to the loudspeaker or - in the case of high signal levels - to a power amplifier.
The precision microphone is connected to one or both test inputs of the UPL analyzer - possibly via an amplifier - depending on the measurement range (see below).

The RUB & BUZZ measurement is always performed in channel 1, the measurement result is available as the result of channel 1 (SENS1:DATA1)
The (unfiltered) frequency response measurement result is available
- in the 22 kHz analyzer as measurement result in channel 2 (SENS1:DATA2)
- in the 110 kHz analyzer as input RMS value in channel 1 (SENS2:DATA1).

The polarity measurement result is displayed as a phase value (SENS4:DATA).

The mentioned measurements can be performed in both analog analyzers, but there are certain differences with a view to operation and connections:

	ANLG 22 kHz	**ANLG 110 kHz**
Connection of precision microphone:	To both measurement channels in parallel	to measurement channel 1
Channel selection	One or two channels; any selection is possible	single-channel only CH1 only
Activation of RUB&BUZZ measurement:	Activation of channel 1: Channel(s) 1, 1&2, 1≡2 or 2≡1	Permanently active
Activation of frequency response measurement:	Activation of channel 2: Channel(s) 2, 1&2, 1≡2 or 2≡1	Activation of Input Disp RMS
Activation of polarity measurement:	FREQ/PHASE → FREQ&PHASE FREQ/PHASE → FREQ&GRPDEL	FREQ/PHASE → FREQ
Deactivation of polarity measurement:	FREQ/PHASE → OFF FREQ/PHASE → FREQ	FREQ/PHASE → OFF

RUB & BUZZ measurement

This measurement is used to detect manufacturing faults in loudspeakers, which are audible as non-harmonic noise or high harmonics. Since even a properly functioning loudspeaker produces k2 and K3 harmonics, THD+N measurements are not suitable in this case. A measurement function is required

instead, which not only suppresses the fundamental but also the next higher harmonics and measures only the residual signal.

The method used here measures the RMS value after a highpass which filters out all "legal" harmonics. Depending on the application, the passband frequency

- is set to a fixed frequency,
- tracks the n-fold generator frequency,
- fulfills a combination of both.

Frequency response measurement:

The frequency response measurement corresponds to an RMS measurement without filter. In the ANLG 110 kHz instrument the accuracy of the RMS measurement is however not fully attained because the measurement time of the input RMS result is not matched to the signal period.

Polarity measurement:

This polarity measurement is tailored to measurements of the loudspeaker *chassis.* It is *not* suitable for measuring loudspeaker *systems* and should not be confused with the POLARITY function for measuring electrical systems such as frequency filters.

The polarity measurement is switched on via the FREQ/PHASE menu item, which is at a higher level than the measurement function (see table further up).

Same as with the POLARITY measurement function, the measured value is indicated with "+ Pol" for correct polarity and "- Pol" for incorrect polarity. In the case of remote or automatic sequence control, a positive numeral is read out for correct polarity and a negative one for incorrect polarity. This numeral also yields a measure for the reliability of the measurement result. The higher the magnitude of the measured value, the more reliable the correct/incorrect polarity criterion. With values between -1.5 and +1.5 the test setup and device settings (e.g. delay) should be checked.

Optimizing the measurement speed:

This measurement function was implemented especially for production tests, i.e. for the purpose of high measurement speed. To ensure the full use of all capabilities the following should be observed:

ANALYZER panel:		
Range	FIX	
FREQ/PHASE	OFF	(if a polarity measurement is *not* required)
Meas Time	GENTRACK	
Sweep Mode	FAST or BLOCK	(if a generator sweep is performed)
OPTIONS panel:		
Beeper	OFF	
Meas Disp	OFF	
Switch off graphics cursor		
Switch off graphics display (3-panel display)		(if only results are required)

The settling time of the filters can also be shortened, but this reduces the measurement accuracy. This is done via the call parameter when the UPL is started:

-tfilxx.yy

xx and yy are factors for modifying the settling time

11 to 99:	Settling time shortened to 0.9 to 0.1
1 to 9	Settling time extended by 10 to 1.1

xx: reduces the settling time of an optional lowpass filter
yy: reduces the settling time of the standard highpass filter

Example: if UPL is started with

UPL -tfil99.30,

(standard value), the settling time of the optional lowpass filter is reduced to 10% and that of the standard highpass filters to 25% of the theoretical value.

Meas Time

(Measurement time)

The measurement time of the RUB & BUZZ measurement is used to adapt the measurement speed to the signal frequency. In most cases - particularly in the case of sweeps - the selection of GEN TRACK is recommended since RUB & BUZZ assumes the use of the internal function generator.

AUTO FAST
AUTO

Automatic matching of the measurement time to the signal frequency taking into account the signal period. This is only useful when an unknown signal frequency is used or the generator frequency modification cannot be accepted, which is unavoidable in the case of GEN TRACK. (see 2.6.5.2 RMS)

VALUE

Numerical entry of desired measurement time. This is only useful when an unknown signal frequency is used or a very weak signal is to be measured. (see 2.6.5.2 RMS)

GEN TRACK

Measurement taking up (at least) one whole generator signal period. If required, the generator frequency can be adapted to the analyzer sample rate. To increase the measurement accuracy in the case of high frequencies, the measurement time is extended to several periods.
This mode guarantees maximum accuracy at a minimum measurement time and should be given preference. (see 2.6.5.2 RMS)

Unit Ch1/2

Selects the units for the RUB & BUZZ measurement results in channel 1 and channel 2.

Reference

Reference values for the RUB & BUZZ measurement.

FREQ MODE

Determines the highpass filter type

FIX

A fixed highpass filter is used; the numeric value of the passband frequency is entered in the menu line below.

GEN TRACK

(Generator tracking)
A tracking highpass filter is used which should preferably be tuned to about the 5th harmonic of the generator frequency. The multiple by which the passband frequency should be higher than the generator frequency can be entered under "Factor" in the next menu line.
The frequency limits, within which tracking of the filter frequency should be performed, can be selected in addition. When a limit is reached (FrqLim Low or Upp) the filter frequency is held at this frequency. Thus a tracking highpass filter can be produced which becomes a fixed-frequency highpass filter below FrqLim Low and/or above FrqLim Upp.
If tracking should be performed over the entire frequency range, the frequency limits should be set to the minimum and maximum value.

Factor

Specifies the factor by which the passband frequency should be higher than the generator frequency. For the Rub & Buzz measurement a factor of approx. 5 would be appropriate.

Specified range: 2 to 20

When the product of generator frequency and factor reaches

- the FrqLim Upp value, the highpass filter is held at this frequency
- the upper frequency limit of the analyzer, Rub & Buzz is not carried out and an error message ("Input? Press Show IO") is displayed instead. The remaining measurement (transfer function in the other channel or below Input Disp) is performed at a higher speed.

Sweep Mode

This menu item is used to increase the speed of frequency sweeps performed with the built-in universal generator.
To increase the sweep speed the following ***conditions*** have to be met by the ***Generator:***

- Function SINE
- Low Distortion OFF
- Sweep control AUTO ...
- X axis FREQ
- Z axis OFF

Operation:
The 1st sweep is performed at the speed of the NORMAL setting. During this sweep the filter and generator parameters to be used for the subsequent sweeps are learned and stored (learn mode).
As long as no new settings are made on the instrument, the FAST and BLOCK mode selected as from the 2nd sweep (play mode) can use the learned parameters. This considerably shortens the setting times for the individual sweep points.
If the start key is pressed or a setting is made on the instrument, the (slower) learn mode is selected again.

Note: *In the play mode, measured values are not indicated on the result display for reasons of speed. Exception: polarity measured at the sweep end.*

NORMAL

Normal sweep trigger without additional speed optimization; can be used for any kind of sweep.
This setting is used internally whenever one of the conditions for optimized sweep synchronization is not met, likewise in the learn mode (see below).

FAST

In 22 kHz analyzer only; speed optimization of sweep without operational restrictions. Measured values are not displayed for reasons of speed.

BLOCK

Further optimization of sweep speed, but in this case the instrument cannot be operated during the sweep. If one or several keys are pressed, the current sweep is terminated and the FAST mode is switched on again where the key functions are executed. Measured values are not indicated for reasons of speed; traces are displayed upon completion of the sweep.

Note: *Settling cannot be switched on in the block mode.*

Filter

(see 2.7 Analyzer Filters (FILTER Panel))
Another (digital) filter can be selected in addition to the standard highpass filter.

Use: *Lowpass filter for band limiting (particularly in ANLG 110 kHz instrument), delay filter for extending the settling time, etc.*

Note: *Same as the standard highpass filter, the filter selected here is only active for measurement channel 1. Channel 2 (in the 22 kHz analyzer) and the input RMS of channel 1 (in the 110 kHz analyzer) are measured without filter.*

FrqLim Low

With FREQ MODE → GEN TRACK only; lower band limit for tracking the frequency of the highpass filter.

If the product of generator frequency and factor drops below the value specified here, the passband frequency of the highpass filter is held at this value.

Specified range:
ANLG 22 kHz: 10.0 Hz to 21.938 kHz
ANLG 110 kHz: 20.0 Hz to 120 kHz

FrqLim Upp

With FREQ MODE → GEN TRACK only; upper band limit for tracking the highpass filter frequency.

If the product of generator and factor exceeds the value specified here, the passband frequency of the highpass filter is held at this value.

Specified range:
ANLG 22 kHz: FrqLim Low to 21.938 kHz
ANLG 110 kHz: FrqLim Low to 120 kHz

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

In the 22 kHz analyzer, the (residual) Rub & Buzz signal in channel 1 and the unfiltered signal in channel 2 can be monitored. This is done by selecting FUNCT CH1 or CH2 provided the selected channel is also active as a measurement channel.

2.6.5.24 Third Analysis (1/3 OCTAVE)

This selection is only available in combination with Option UPL-B6 (Extended Analysis Functions). It is generally not available with the 110 kHz analyzer.

With the third analysis, the levels in up to 30 third-octave bands are measured simultaneously. The analysis is performed according to standard IEC 1260 of 1995 with level accuracy of class 0 (± 1,0 dB).

The bandwidth of a third-octave band relative to the band center is $\sqrt[6]{2} - \frac{1}{\sqrt[6]{2}}$ (= 1/3 octave). The third-octave filters are designed as 4th-order Chebychev filters. The reference frequency of 1 kHz is used as a basis for calculating all the other center frequencies of the band.

The third-octave bands to be measured are selected by entering lower and upper frequency limits. A separate RMS value is determined for each third-octave band and displayed either graphically or numerically. The total RMS value for all the selected third-octave bands is displayed. If necessary, it can also be displayed as a bar graph or (for specialist applications with frequency sweep) a curve plot.

The precisely calculated third-octave bands are used as a basis for the *measurement*. The nominal band center frequencies are rounded to two or three significant digits and used for the *numeric representation* of the thirds (operation SPECTR LIST). With the *graphic representation* (operation SPECTRUM), only the octaves are labelled as space is limited.

The measurement range of the third analysis begins at the nominal band center frequency of 25 Hz and ends at 20 kHz. The total bandwidthranges from 22.1 to 22627.7 Hz.

Third analysis in UPL is performed for one channel only. Dual-channel measurements should normally be avoided, as the multiplexing that is required makes continuous measurement of both channels impossible and the channels therefore have to settle to steady state each time a single measurement has been performed. However this measurement mode may be suitable for single measurements with long measurement times. Of course both traces may also be used also for single-channel measurements, eg trace B for displaying a comparison spectrum. If two traces are used, the thirds are superimposed, which gives a very clear picture on a colour display: the overlaying portions of the two traces are displayed, as in other measurements, a mix of the colours used.

Pink noise, which can also be generated by the UPL, is recommended as *trigger signal* for the third analysis. Unlike white noise, its level roll-off of $\sqrt{1/f}$ compensates for the apparent level increase encountered with third analysis, which results from the absolute bandwidth increasing as the frequency increases.

Meas Time

VALUE

(Measurement Time)

The only parameter determining the measurement speed is the measurement time, which is entered as a numeric value. To minimize measurement uncertainties, the selected measurement time is rounded to integer multiples of 512 samples, which corresponds to a step width of approx. 10.6 ms for the analog analyzer (internal sampling rate 48 kHz). For long-time measurements, measurement times of up to 12 hours can be selected.

The measurement time also determines the update rate of the third analysis. Shorter measurement times lead to results being displayed faster but for shorter times. Each time the selected measurement time elapses, the *third* results are updated. No intermediate results are displayed. The update rate of the measurement result can be reduced by entering the "reading rate" in the OPTIONS panel. If the selected measurement time is too short, the lower third measurement results become inaccurate ("noisy"). If the measurement results are of considerably more interest than the graphic representation, the selected measurement time should be long enough to yield sufficiently accurate measurement results for even the lowest third that is required.

Specified range:

ANLG 22 kHz: 10.67 ms to 720 min (12 h)
DIGITAL: 512 / f_{sample} to 720 min

Units: s | ms | µs | min

Note: *The measurement time of the first measurement is increased by the settling time of the slowest third octave filter. To reduce this delay the "frequency limit low" can be raised. Thus the calculation, delay and display of the lower tird octaves are obmitted.*

Max Hold

Hold function for the maximum result of each third. The function can be turned off. Reset by pressing the START key. Just like the measurement results of the thirds, the max-hold values can be displayed either graphically as horizontal markers in the spectrum or numerically in a spectrum list. They are available via auto and remote control. To present numerical results, switch on Scan #2 (PgUp or PgDn key). Graphically the maximum values are indicated by narrow horizontal lines at the top of the associated third bars.

OFF Max-hold function switched off; only the third bars are displayed.

FOREVER Max-hold function switched on; the markers lie on the maximum values; reset only by starting the measurement (START key).

SLOW DECAY Max-hold function switched on; the markers lie on the maximum values for the "hold time" to be set in the following line and then decay exponentially (time constant 0.5 s).

FAST DECAY Max-hold function switched on; the markers remain on the maximum values for the "hold time" to be set in the following line and then go back to the current measurement value for the third.

Note: *The counter for the hold time is reset and restarted whenever a new maximum value occurs. Each third has its own counter, so each marker can move independently.*

Hold Time

Only for Max Hold --> SLOW / FAST DECAY

Setting of the time for which the maximum value of a third is held before the marker returns to the measured value. The selected hold time does not influence the decay time.

Unit Ch1/2

(See 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(See 2.6.5.1 Common Parameters of Analyzer Functions)

GEN TRACK is not available for third analysis, as this analysis is usually triggered by noise signals (eg pink noise), for which generator tracking is not defined.

Filter

(See 2.7 Analyzer Filters (FILTER Panel))

A standard or user-defineable filter can be selected.

FrqLim Low

Lower band limit for third analysis. The representation and calculation of the third bands start with the band containing the lower limit frequency. Any signals below the lowest third band will not be included in the calculation of the total RMS value. The higher the lower limit frequency, the faster the signal will settle and the shorter the time for first measurement.

Specified range:

ANLG 22 kHz:	10.0 Hz to 21.938 kHz
DIG 48 kHz:	10.0 Hz to f_{max}

Note: *In single measurement mode (e.g. sweep, 2-channel measurement) all third octave filters have to settle before start of measurement. Thus the meassurement time for* ***each*** *single measurement is increased by the the filter delay. In order to reduce filter delay third octave of low frequencies should be avoided. "Frequency limit lower" should be set as high as possible.*

FrqLim Upp

Upper band limit for third analysis. The representation and calculation of the third bands ends with the band containing the upper limit frequency. Any signals above the top third band will not be included in the calculation of the total RMS value. Frequency limit upper does not affect the measurement time.

Specified range:

ANLG 22 kHz:	FrqLim Low to 21.938 kHz
ANLG 110 kHz:	FrqLim Low to f_{max}

SPEAKER

(See 2.6.6 Headphone/Speaker Output)

The input signals of channel 1 and/or channel 2 (without filter) can be monitored.

2.6.6 Headphone/Speaker Output

The Headphone/Speaker Output UPL-B5 permits to monitor both analog and digital measuring and test signals during the measurement. For this purpose, the built-in loudspeaker or the externally connected headphones are used. The impedance of the headphones should be 600 Ω so that a distortion-free operation is guaranteed even with full volume. When connecting headphones with lower impedance, distortions have to be taken into account depending on the power level. The maximum peak voltage at the headphones is 8 volts.

Principle of operation:

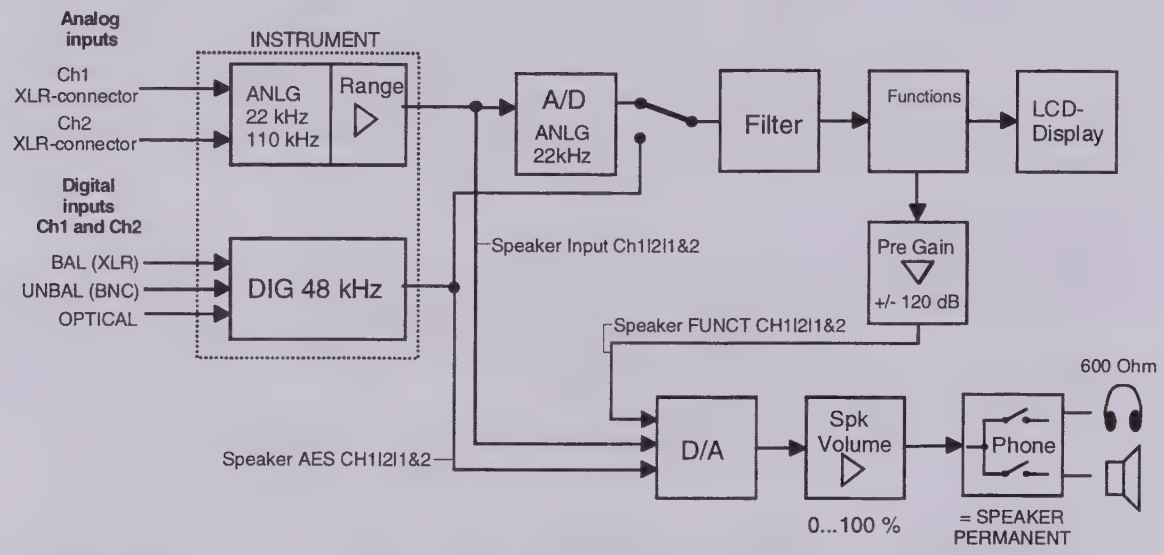


Fig. 2-28 Principle of operation of the headphones/speaker output

The input signals of all analog analyzers (INPUT) and the output signals of all analyzer level functions may serve as signal sources for the monitor output, in addition monitoring of THDN and Rub&Buzz residual signal can be switched on.

Table 2-37 Monitoring realized for the analyzer functions

Functions	Monitoring possible	Output signal
RMS, RMS Sel, PEAK, Quasi Peak	yes	filtered or unfiltered input signal
THD+N, RUB&BUZZ	yes	residual signal or unfiltered input signal
DC, THD, MOD DIST, DFD, WOW & FL, FILTER SIM, FFT, POLARITY, WAVEFORM, COHER, 1/3-Octave	no	Input signal

Pre Gain permits a signal amplification of +/- 120 dB. This permits to boost even weak residual signals such that they can be monitored. If the AES/ EBU option is installed, the AES/EBU signal can also be monitored at the input (AES).
A level control (volume) permits setting of the volume. In the case of Phone SPEAKER, the internal loudspeaker is automatically switched off by connecting the headphones. In the case of Phone PERMANENT, only the loudspeaker is switched on and off using the Speaker-off key.

The Speaker menu is located at the end of the ANALYZER panel and linked to the measurement function, i.e. it is stored and loaded together with the function. Thus the monitoring output can be configured separately for each measurement function. For instance, a high preamplification is required for monitoring residual signals (THD+N, Rub&Buzz, RMS SEL with tracking bandstop filter) while a considerably lower preamplification is sufficient for (filtered or unfiltered) RMS measurements to avoid overdriving and excessive volumes.

To protect the user against excessive volumes (particularly when headphones are connected), the monitoring output is automatically switched off when SETUP settings are loaded, the analyzer instrument or a function is changed or the Speaker command is given. In this case the monitoring output has to be switched on again with the Speaker-off key (LOCAL key). If headphones are used, the Speaker menu should be checked prior to switching on to avoid excessive volumes increased through inadvertent gain setting ("Spk Volume", "Pre Gain").

Note: *The monitor output is designed as*

- *control output for monitoring the input signal by means of headphones or loudspeaker or for*
- *monitoring the signal using an oscilloscope, since analog signals from 20 Hz to 110 kHz can be monitored with a frequency response of ±0.2 dB and digital output signals with a sample frequency of 27 Hz to 55 kHz. Due to noise sidebands of the internal PLL, a THD + N measurement does not provide the excellent data usually supplied by the measuring path of the UPL (distortion ≤-60 dB above the frequency range from 20 Hz to 110 kHz). However, these non-harmonic interfering signals are inaudible due to the psychoacoustic masking effect of the human ear.*

ANALYZER panel

SPEAKER — Monitor output

OFF	Monitor output is switched off
INPUT Ch1	Monitoring the input signals of the analog analyzers ANLG 22 kHz and ANLG 110 kHz on channel 1. The signal is applied to both output channels.
INPUT Ch2	... on channel 2
INPUT Ch1&2	Monitoring the input signals of the analog analyzers ANLG 22 kHz and ANLG 110 kHz on channel 1 and channel 2 (stereo operation). If channel 1 or channel 2 are selected as analyzer input, only the left-hand or right-hand phones output can be monitored correspondingly.
DIG IN Ch1	Monitoring of the left channel of the digital audio interface of the digital analyzer DIGITAL (Digital Audio I/O Option UPL-B2)
DIG IN Ch2	... of the right channel.
DIG Ch1&2	... of both channels.
	Note: *Monitoring of the digital audio signals is only possible if the Digital Audio I/O Option UPL-B2 is installed.*
FUNCT Ch1	Monitoring of the measurement function output of the analog analyzer ANLG 22 kHz for channel 1. If filters are switched on for the measurement function, the filtered signal (or the residual signal for THD+N, Rub&Buzz or RMS SEL) can also be monitored here.
FUNCT Ch2	... channel 2.
FUNCT Ch1&2	... both channels (stereo operation).
INPUT JITT	Available only in the DIGITAL analyzer with Digital Audio I/O option (UPL-B2) in Meas Mode JITTER/PHAS. The demodulated jitter signal is applied to the ANLG 110 kHz analyzer and can be listened to.
INPUT COMM	Available only in the DIGITAL analyzer with Digital Audio I/O option (UPL-B2) in Meas Mode COMMON/INP. The superimposed common-mode signal at the digital inputs is applied to the ANLG 110 kHz analyzer and can be listened to.

Pre Gain — For the menu items SPEAKER FUNCT CH1/2/1&2 a gain or attenuation of the function output can be set in the range ± 120 dB. If the gain is set too high, the signal is limited at the monitor output.

Spk Volume — Volume for the monitor output, settable from 0 to 100%

Phone

Configuration of the monitor output at the phones connector.

= SPEAKER

When connecting the headphones, the internal loudspeaker is automatically switched off.
Phones output is operated in conformance with the loudspeaker, i.e. the Speaker-off key (LOCAL key) switches off the internal loudspeaker or phones output. The monitor signal sounds either from the built-in loudspeaker or from the connected headphones.

PERMANENT

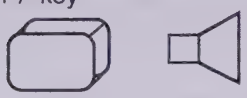
Phones output is permanently switched on. Speaker-off key only acts on the internal loudspeaker irrespective of whether the headphones are connected up.
In this case, the internal loudspeaker also remains active with the headphones inserted.

Keys for speaker control:

LOCAL key

This key is used to switch on/off the internal loudspeaker in local mode of the UPL (Speaker-off key). In remote mode, the first keystroke switches to the local mode.

+ / key



This key opens a box for faster setting of the monitoring volume (Spk Volume).

Example of application: Monitoring the distortion of a signal

In the UPL, the signal distortion can be monitored either directly when a THD+N measurement is performed or by switching on a narrow bandstop filter in the case of an RMS SELECT measurement.

When a **THD+N measurement** is performed, the signal to be monitored is routed via a digital filter or a second (analog) notch filter. The frequency of the signal is permanently monitored and the notch filter immediately fine-tuned, if required. In this case the monitoring output is briefly muted.

Depending on the selected generator and the quality of the test signal, a different setting is required for menu items "Fundamental" and "Dyn Mode":

- Internal universal generator (Low Dist → OFF)

  Select Fundamental → GEN TRACK; the dynamic mode is arbitrary. When the generator frequency is changed, the internal notch filters are automatically tuned to the new fundamental.

- Internal low-distortion generator (Low Dist → ON)

  Select Fundamental → AUTO. (When the low-distortion generator is switched on, GEN TRACK is ignored and handled internally in the same way as AUTO.) This is to avoid the generator frequency being slightly outside the stopband range of the two notch filters. The dynamic mode PRECISION may be selected if the signals to be measured are only slightly distorted or noisy.

- External generator:

  Select Fundamental → AUTO. The signal frequency is permanently monitored and the internal notch filter fine-tuned, if required. Select the dynamic mode PRECISION or FAST depending on the signal quality.

***Note** on monitoring the residual signal during the THD+N measurement:*

- *The monitoring output is muted for approx. 1 s every time a change is made in the GENERATOR or ANALYZER panel before the THD+N measurement is (re)started or when the notch filter is internally tuned. This is not a malfunction but should protect the listener against clicks and noise while the settings are made, which would be very disturbing because of the high gain of the residual signal.*
- *If external signal sources are used, it cannot be avoided for the fundamental to go outside the stopband range of the notch filter and being applied with high level to the monitoring output whenever the frequency is changed. As soon as the THD+N measurement routine identifies a new fundamental, the monitoring output is muted and the notch filter adjusted.*

  ***Remedy**:*

  - *This effect can be avoided through the use of an internal generator.*
  - *If an external generator has to be used, the following procedure is recommended:*
    Stop or abort the current (permanent) measurement using the STOP or SINGLE key, then set the external generator and restart the measurement with the START key.
  - *If the time of the generator switchover cannot be predicted, a short measurement time should be selected to minimize the period before the signal is muted.*
    1. *Reduce Meas Time SUPERFAST or the FFT size (with post-FFT switched on).*
    2. *Switch post-FFT OFF.*
    3. *Switch result display off.*

- *If the loudspeaker is not switched on again after muting although Speaker was neither switched off by means of the PHONE OFF key nor via the Speaker menu, it could be that the measurement routine cannot find a reliable and sufficiently strong signal.*

  ***Remedy**:*

  - *Switch off the analog notch filter by selecting the dynamic mode FAST or*
  - *Fundamental GEN TRACK, provided the internal universal generator is used.*

- *If the signal to be measured contains considerable noise or strong harmonics, it could happen that the fundamental after the analog notch filter cannot be detected.*

  ***Remedy**:* as above

- *Any kind of DC (DUT, DC offset of notch filter) may cause the monitoring output to be overdriven and muted.*

  ***Remedy**:*

  - *Perform or switch on a DC offset calibration in the OPTIONS panel.*
  - *Switch on the highpass filter (Filter →HP...),*
  - *Switch on AC coupling (Couple CHx→ AC).*

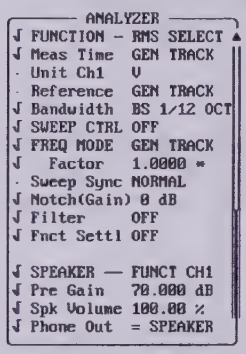
If an **RMS SELECT measurement** is performed, the distortion can be monitored by cutting in a narrow bandstop filter. The frequency of the bandstop filter can be permanently set or automatically adjusted when the frequency is changed in the GENERATOR panel.

The DUT is connected, for instance, between analog generator input 1 and analog analyzer input 1. Settings on the UPL:

Load the UPL default setting in the FILE panel.

```
LOAD INSTRUMENT STATE
Mode        DEF SETUP
```

Settings in the UPL ANALYZER panel:



With FREQ MODE GEN TRACK, the bandstop center frequency follows the frequency setting in the GENERATOR panel.
FREQ MODE FIX holds the bandstop frequency irrespective of the generator frequency.

With NOTCH(Gain) 0 dB, an analog notch filter is switched on which increases the stopband attenuation by another 40 dB (in addition to the 100 dB attenuation of the bandstop filter).

Switch on loudspeaker: press Speaker off key (LOCAL key) or open volume box
(+/- key) and adjust the desired volume.

By setting Pre Gain, the residual signal can now be boosted above the audible level.
Depending on the distortion of the DUT, the harmonics of the test frequency can be clearly distinguished from the noise.

Depending on the selected generator, menu items Bandwidth and FREQ MODE can be set in different ways:

- Internal universal generator (Low Dist→ OFF)

  Select FREQ MODE → GEN TRACK; the set bandwidth may be as narrow as desired (Bandwidth → BS 1%) because the universal generator features a very high frequency stability. When the generator frequency is varied, the fundamental is automatically suppressed by the tracking bandstop filter.

- Internal low-distortion generator (Low Dist → ON)

  When the low-distortion generator is used, which features a high spectral purity but a slightly reduced frequency stability, it may happen that the generator frequency is slightly outside the bandstop filter range BS 1% and the fundamental is not completely suppressed. *Remedy*: Select

  – a wider bandstop filter (bandwidth → BS 3%, BS 1/3 OCT, BS 1/12 OCT) *or*

  – FREQ MODE → FIX and tune the center frequency manually to the generator frequency or, the other way round, vary the generator frequency by a few Hz so that the fundamental is optimally suppressed.

- External generator:

  Select FREQ MODE → FIX and tune the center frequency as accurately as possible to the generator frequency. For generators with a non-stabilized frequency, a wideband bandstop filter should be selected in addition (bandwidth → BS 3%, BS 1/3 OCT, BS 1/12 OCT).

***Note** on monitoring the residual signal during the RMS selective measurement:*

Any kind of DC (DUT, DC offset of notch filter) may cause the monitoring output to be overdriven and muted.

***Possible remedies**:*

- *Perform or switch on a DC offset calibration in the OPTIONS panel.*
- *Switch on highpass filter (Filter →HP...),*
- *Switch on AC coupling (Couple CHx → AC).*

2.6.7 Applications

2.6.7.1 Crosstalk Measurement

Crosstalk means the -undesired- coupling of signals of one channel to another communication channel. It is usually indicated as a function of the frequency. It is measured by modulating one channel by means of measuring the amplitude in the unmodulated channel. Since the coupled signals are normally low and may correspond to the signal-to-noise ratio, the full dynamic range should be used. The values are indicated in dB, the output amplitude of the modulated channel being used as reference.

• Basic setting

The generator is set to SINE and a frequency sweep is activated. Since crosstalk normally does not reveal steep variations over the frequency, approx. 20 to 30 test points with logarithmic spacing are sufficient in the range from 20 Hz to 20 kHz. VOLTAGE is set such that the maximum voltage is reached at the DUT output.

The RMS & S/N (with S/N Seq OFF) function is used in the analyzer to measure the level with AUTO or AUTOFAST mode. This is a two-channel measurement, i.e., Channels(s) is set to 2=1. Range AUTO matches the different levels automatically. INPUT DISP and FREQ/PHASE measurements should be switched OFF to increase the measurement speed.

Since the measurement is to be displayed as CURVE PLOT, operation is set accordingly in the DISPLAY panel. Scan count is set 1. Scale B is selected NOT EQUAL A. Unit should be set to dBr in both channels and the normalize value to 1.0 * or 0 dB.

• Measuring crosstalk from CH2 to CH1

The generator setting is "Channel(s) 2" in order to switch on channel 2.
In the DISPLAY panel, Trace A is set to FUNC CH1 and reference to MEAS CH2.
Trace B is OFF. -Pressing the SINGLE key starts the first measurement sequence.

• Holding the measurement

Since the same display shall contain crosstalk of the other channel, the first measurement must be "held" by selection of the setting Trace A HOLD. If AUTO ONCE has not yet been selected for Scale, the automatic scaling can now be initiated.

• Measuring crosstalk from CH1 to CH2

In the GENERATOR panel, Channel(s) 1 is selected in order to switch on the other channel.
Trace B is set to FUNC CH2 and MEAS CH1 is selected as reference.
Pressing the SINGLE key starts the 2nd sweep.

• Post-processing/storage

Since the crosstalk values of the individual channels do normally not deviate considerably from each other, the scaling of TRACE A can be copied using Scale B EQUAL A.

The complete measurement can then be stored in a file by entering Store TRACE A+B and a file name in the FILE panel. Besides, a screen hard copy can be selected for documentation purposes and output by pressing the HCOPY key in the OPTIONS panel.

• Copying the functions to be executed in the STATUS panel

This measurement is a typical application for the STATUS panel. The few command lines to be executed can be copied into the common STATUS panel by marking them in order to avoid manifold

switchover between GENERATOR and DISPLAY panels (cf. 2.8 STATUS panel). Assuming that nothing has been marked, the Channel(s) command is ticked off in the GENERATOR panel and the lines TRACE A, Reference (A), TRACE B, Reference (B) and Scale B, if required, are ticked off in the DISPLAY panel.

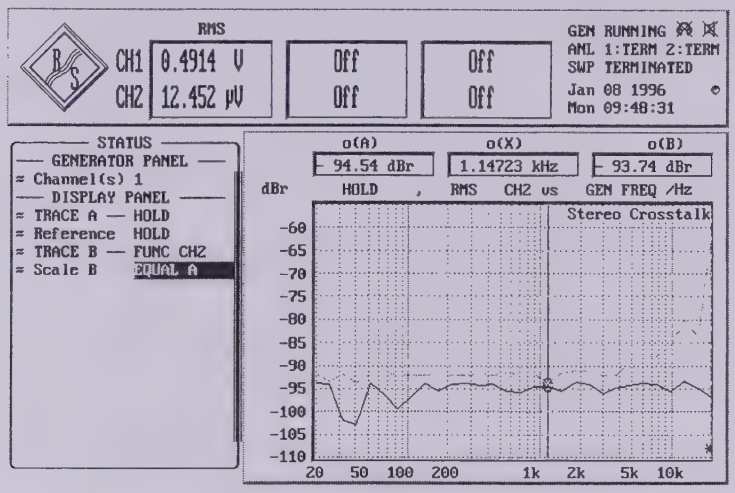


Fig. 2-29 STATUS and GRAPHICS panels with crosstalk measurement

2.6.7.2 Linearity Measurements

In linearity measurements the output level is plotted versus the input level. The unit normally used is dBr but V/Vr can also be selected. If a fixed reference value is used, a straight rising line is obtained. To accentuate departures from linearity, a straight horizontal line would be desirable. This line is obtained when the measured values are not referenced to a fixed value but to the input frequency.

The UPL does not offer a separate function for linearity measurements. Such measurements are defined as a special reference of the level measurement. This offers the following **advantages**:

1. Linearity measurement not confined to one single measurement function. *All level measurements* (RMS, RMS select, quasi-peak and all peak measurements) can be used for linearity measurements.
2. Switchover between linearity measurement and (absolute) level measurement is effected by selecting the unit (menu line "Unit 1" or "Unit 2"). It is thus possible to display the linearity measurement in one channel and the absolute level in the other.
3. By selecting the reference (menu line "Reference"), a switchover is made between a fixed or a floating reference (linearity measurement). Thus the linearity measurement can be displayed in one channel and the level referenced to a fixed value in the other.

***Note**: The reference used for linearity measurements is defined as **"floating reference value"** in this manual. In contrast to the commonly used fixed reference, each measured value has a reference value of its own.*

The linearity measurement can be performed by means of a sweep. Measured values can be numerically or graphically displayed in the GRAPHICS panel and normalized. Moreover, the nonlinearity of each measured (level) value can be directly read from the result window without a sweep being set and performed.

Either the internal generator (GEN TRACK) or - when both channels are switched on - one of the two measurement channels (MEAS CH 1/2) can be selected as a reference for the linearity measurement. A measurement channel has to be selected as a reference when an external generator is used or if reference is to be made to a specific point in the test setup.

***Note**: A two-channel linearity measurement assumes that neither of the measurement channels is needed as a reference. With MEAS CH1 or MEAS CH2 selected as a reference, the linearity measurement can be performed in one channel only. Being referenced to itself, the other channel yields 0 dBr.*

More possibilities are available when the measurement is carried out in the form of a sweep with the result displayed in a graphics window:

1. When stored as a trace file, the level curve of a reference item (golden unit) can be selected as a reference under FILE in the DISPLAY panel. Thus departures from linearity can be displayed with a reference to this golden unit without the latter being available for the measurement.
2. The level curve measured in the other trace (or loaded from a file) can be directly selected as a reference in the DISPLAY panel (OTHER TRACE). Thus it is possible to subsequently reference the absolute level curves of the two channels to each other.
3. The sweep shows the linearity deviation (e.g. in dBr) from the selected reference curve. This deviation is not necessarily around 0 dBr. If the DUT has a gain or loss, the deviation may be above or below this value. The gain factor of the DUT can be compensated for by a scaling factor which can be entered either numerically or by means of an automatic 0-dB scaling to the current cursor position.

Note: *When measuring D/A or A/D converters using the internal UPL generator, the linearity measurement (with GEN TRACK) leads to the physical problem of referencing an analog voltage to a digital one (or vice versa). UPL internally calculates with a* ***conversion factor*** *of*

1V / 1FS or 1FS / 1V

Same as the gain factor, this conversion factor can also be compensated for by the scaling factor.

1-channel linearity measurement referenced to measurement channel 1:

1. Select analyzer (ANLG 22 kHz or ANLG 110 kHz) according to the required frequency.
2. Select a level measurement (RMS, RMS select, quasi-peak or peak) and, if necessary, the measurement mode suitable for the measurement task.
3. If a curve is to be swept, further settings have to be made in the DISPLAY panel: Operation must be set to Curve Plot, FUNCT CH2 should be selected for trace A and trace B should be OFF.
4. Select dBr or V/Vr for channel 2 and trace A (in the ANALYZER and, if required, the DISPLAY panel).
5. Select MEAS CH1 as a reference (menu line REFERENCE in the ANALYZER and, if required, in the DISPLAY panel). The measurement result of channel 2 is then referenced to the input of channel 1.
6. The linearity deviation is displayed in the result display of channel 2 with the selected unit. On triggering a (SINGLE) sweep, the linearity characteristic is graphically displayed versus the input level.

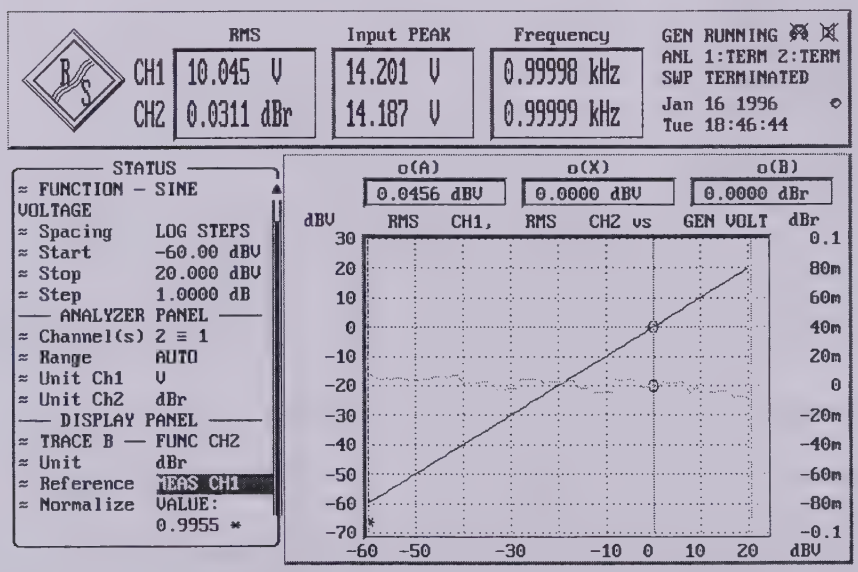


Fig. 2-30 Configuration of UPL for linearity measurement referenced to channel 1, the linearity characteristic being displayed on trace B, the absolute reference channel on trace A.

2-channel linearity measurement referenced to internal generator:

1. First configure and set the internal generator (sinewave signal, level sweep, signal frequency, etc.).
2. Select analyzer (ANLG 22 kHz or ANLG 110 kHz) according to the required frequency.
3. Select a level measurement (RMS, RMS select, quasi-peak or peak) and, if necessary, the measurement mode suitable for the measurement task.
4. Further settings are to be made in the DISPLAY panel: Operation must be set to "Curve Plot", FUNCT CH1 should be selected for trace A and FUNCT CH2 for trace B.
5. Select the unit dBr or V/Vr for both channels and both traces (in the ANALYZER and DISPLAY panels).
6. Select GEN TRACK as a reference (menu line REFERENCE in the ANALYZER and DISPLAY panel). Both measurement inputs are now referenced to the set generator level.
7. The linearity deviation is shown in the result displays with the selected unit. On triggering a (SINGLE) sweep, the linearity characteristics of both channels are displayed versus the generator level.

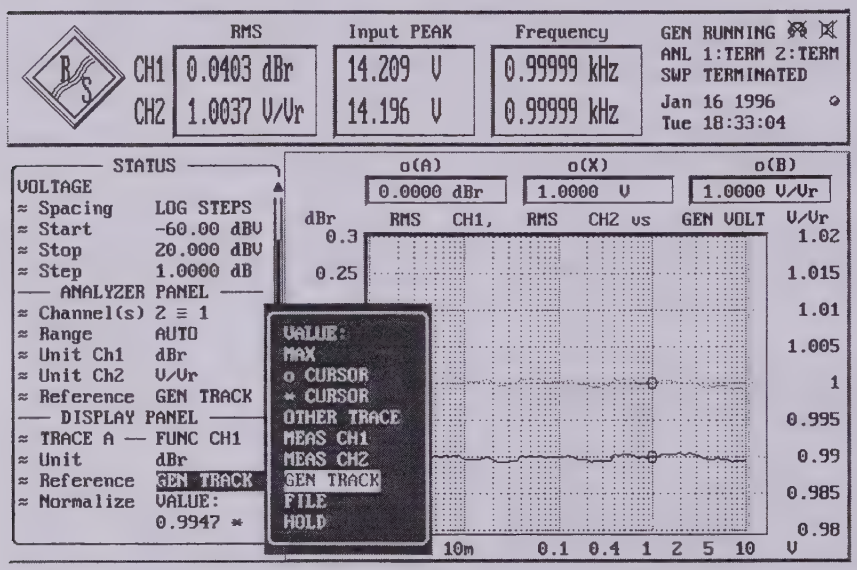


Fig. 2-31 Configuration of UPL for 2-channel linearity measurement referenced to the internal generator; display of linearity curve of both channels

After termination of the sweep, the swept curves can be normalized to one (or two different) points (e.g. 1 V). In this case the curve is vertically shifted so that it crosses the 0-dBr line at the selected reference points:

1. Switch over to the GRAPHICS panel (GRAPH key or ALT+R). Activate one or both graphics cursors, if required.
2. Move the cursor(s) to the desired reference point(s).
3. Return to the DISPLAY panel (DISP key or ALT+D).
4. Open the menu item Normalize of Trace A, select O-Cursor or ✱- cursor, depending on which one was used for marking the reference point.
5. If required, repeat step 4 for Trace B.

Note: *If the linearity characteristic is to be determined at various frequencies, this can be realized by means of the two-dimensional sweep (with frequency on the Z axis). The individual curves overlap in the display and yield a set of curves.*

2.6.7.3 Fast Frequency-Response Measurements

Usually, frequency-response measurements are performed using (generator) frequency sweeps and RMS measurement. Although the UPL offers a very high RMS measurement speed (approx. 15 ms per measured value), such a sweep may lead to a total measuring time, which is unacceptable due to the large number of sweep steps to be performed. In other words faster modes are called for.

A combination of the FFT function and the generator signal RANDOM, Domain FREQ would be an alternative. The generator can be synchronized to the spacing of the analyzer, i.e. each generated frequency line of the (pseudo) random signal is assigned exactly one line of the FFT. Thus FFT windowing can be omitted and a maximum frequency and level accuracy is obtained.

After outputting the generator random signal, all measurements can be performed at the speed of a single FFT. Thus, the measurement speed only depends on the FFT size, which should be selected so that the desired (linear) frequency resolution is just obtained.

Note: *Logarithmic spacing is not possible with FFT; irrespective of this, logarithmic scaling of the X axis can be selected in the DISPLAY panel.*

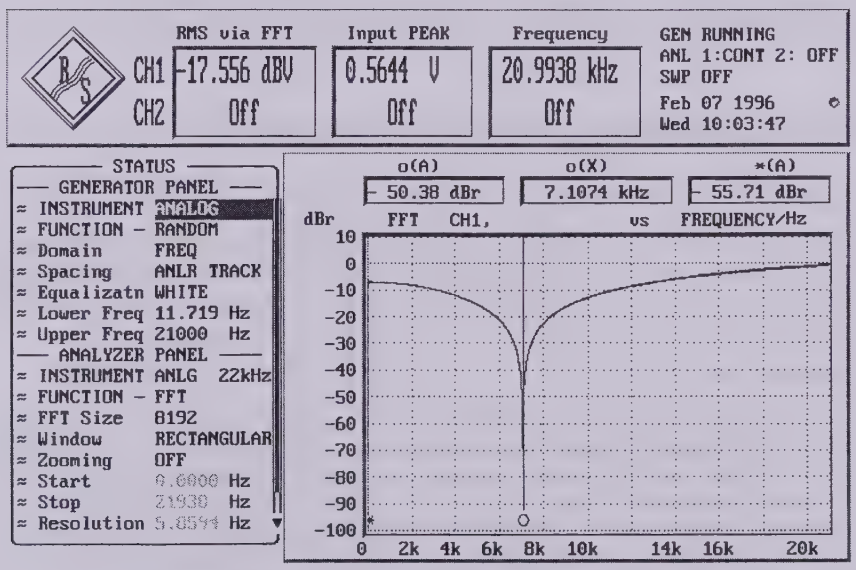


Fig. 2-32 Configuration and result of fast frequency-response measurement

2.6.8 Optimizing the Measurement Speed

A high measurement speed is of particular importance for remote control as the measurement time directly influences the program run time. For this reason program sequences are given in Section 3.15.10 Tuning - Setup for Maximum Measurement Speed, to optimize the measurement speed in the case of remote control.

Short measurement times are also desirable in manual operation, particularly for sweeps and FFT, in order to obtain a real-time characteristic (e.g. for tuning procedures). For this reason a few general hints will be given below on how to cut down on the available measurement time. Optimization measures can be classified in 4 groups:

1. Speed optimization *without affecting* the measurement accuracy
2. *Compromise* between measurement time and accuracy or dynamic
3. Speed optimization through use of *internal* generator,
4. Optimizing the sweep speed

A brief form of these hints is available in the UPL online help functions (see 2.3.7 Help Function) under the item "Optimization".

1. Speed Optimization without Affecting Measurement Results

- Selecting a suitable analyzer instrument (analog measurement signals only)

  In the ANLG 22-kHz instrument, the two channels can be measured in parallel (synchronously) already during sampling. This analyzer also offers a wider conversion range and a lower frequency limit and should therefore be used in all cases where an upper measurement limit of 22 kHz is sufficient.

- Switching off unused measurement inputs

  An unused measurement input may considerably extend the measurement time as a measurement is only terminated when a measured value is available for the unused input too. Some measurement functions (e.g. RMS with automatic measurement time, THD+N) require a much longer time for measuring low signal levels (noise) but even if a signal is present on channel 2, the measurement time is certainly longer than in the case of 1-channel operation, as also the 2nd channel has to be completely evaluated and displayed. In the ANLG 110-kHz instrument the two channels are measured sequentially so that the measurement time is at least twice as long.

- Switching off the "Beeper"

  In the setting "Beeper ON" there is a short sound of several 100 ms duration after each (single) sweep which indicates the sweep ending. During this time no device activities are possible. Especially with short sweeps this dead time is disturbing. Therefore the Beeper function should be switched off while sweeps are running - especially under remote/automatic control - if no acoustic reply of sweep end is required.

- Switching off unused result displays

  If the result displays for FREQUENCY and INPUT DISP are not required they should be switched off. In addition to saving the time required for evaluation and display of these values, some measurement functions (e.g. RMS) can be terminated more quickly.

- Switching off settling functions

  For most signals the settling function is not required. If the DUT provides a stable signal, the UPL yields settled values even without the settling function. Settling (or averaging) multiplies the measurement time by at least the number of the set samples (see 2.3.4 Settling Process).

- Switching off filters that are not required

  Each (digital) filter increases the total measuring time because of its settling time. Unused filters should therefore be switched off in the ANALYZER panel.

- Switching off the measurement delay function ("Delay" under START CONDITION)

  With the aid of this function DUT delays can be corrected. The start of the 1st measurement and consequently of each sweep point are delayed for a defined period each time the generator or analyzer setting is changed. If a start delay is not required, this time should be set to 0.0 (see 2.6.4 Ways of Starting the Analyzer, Ext. Sweep).

- Manual selection of analyzer level range (analog measurement signals only)

  If the level of the signal to be measured is known and a limited measurement range can be accepted, the analyzer level range should be manually selected (Range FIX). A range corresponding to the highest expected level should be set, an UNDERRANGE being taken into account. This prevents a new measurement with a corrected range setting to be performed. To ensure that the measurement will not be falsified by a higher signal level, "Range LOWER" may be selected. With this mode selected the measurement function is able to correct the measurement range in the case of OVERRANGE (see 2.6.2 Configuration of the Analog Analyzers).

2. Compromise between Measurement Time and Accuracy or Dynamic

The methods below can only be used with certain measurement functions.

- Selection of low measurement dynamic (dynamic mode FAST, for analog measurement functions THD, THD+N/SINAD, DFD, MODDIST only).

  If signals not making full use of the UPL dynamic range are to be measured, e.g. distortion above 0.1%, precision measurements are not required. Consequently, the measurement time can be reduced by about a factor of 2 without any loss in accuracy.

- Reducing the FFT size for FFT and THD+N

  Halving the FFT size also halves the measurement time required for FFT. This also applies to FFT-supported measurement functions like THD+N and SINAD.

  In the case of THD+N/SINAD measurements, reducing the FFT size does not only reduce the time required for (post)-FFT but also the THD+N/SINAD measurement time, irrespective of whether post-FFT is activate or not. This however is at the expense of the measurement accuracy. (see 2.6.5.7 THD+N/SINAD).

- Reducing the numeric value of "Measure Time" for RMS, RMSSEL, PEAK, QPEAK and DC

  If a fixed measurement time is used, the desired time can be directly entered as a numeric value. Entering a shorter measurement time reduces the measurement accuracy. The measurement time is defined for each single measurement. With AUTO ranging selected, a new measurement performed because of an unfavorable (UNDERRANGE) or incorrect (OVERRANGE) level range leads to a total measurement time which exceeds the desired one.

- Selecting AUTO FAST for RMS and RMSSEL

  Automatic selection of the measurement time in the case of RMS measurements ensures that the shortest possible measurement time is selected for the desired accuracy (AUTO or AUTO FAST) in the case of unknown signals irrespective of the test frequency. If an accuracy of 1% is sufficient, AUTO FAST should be used (see 2.6.5.2 RMS).

- Extending the span for zoomed FFT

  The span for zoomed FFT should not be smaller than that required by the necessary frequency resolution. Doubling the span halves the frequency resolution and the measurement time (see 2.6.5.12 FFT).

- Increasing the bandwidth for RMSSEL

  The larger the band of the digital bandpass or bandstop filter, the shorter the measurement time. The measurement can be speeded up if a reduced selectivity is sufficient for the signal frequency (see 2.6.5.3 RMS SELECT).

- Reducing the attenuation and/or the edge steepness of user-defined filters

  Both measures reduce the settling time of the filters and thus the measurement time (see 2.7.2 Creating the User-definable Filters).

- Reducing the order of user defined high and low passes

  By this measurement too the response time of the filter and consequently the measurement time is reduced (see 2.7.2 Creating the User-definable Filters).

3. Speed Optimization Through Use of Internal Generator

- Selection of GEN TRACK modes, if available (RSM, RMSSEL, THD, THD+N/SINAD).

  With "Meas Time GEN TRACK" selected for RMS and RMSSEL, the measurement time can be exactly set to integral periods of the set generator frequency. The generator frequency can then be slightly modified (see 2.6.5.2 RMS).

  With "Fundamental GEN TRACK" selected for RMSSEL, a preliminary measurement for determining the frequency is not required. (see 2.6.5.3 RMS SELECT).

  With "Fundamental GEN TRACK" selected for THD+N/SINAD, the 1st FFT is performed with the correct resolution even if the selected FFT size is too small. In the case of low frequencies and a small FFT size, the measurement speed is almost doubled (see 2.6.5.7 THD+N/SINAD).

  Selecting "Fundamental GEN TRACK" for a pure THD measurement does not noticeably increase the measurement speed. Since an accurately defined fundamental is required for the THD measurement, "Fundamental AUTO" should be used.

- Fast frequency-response measurement possible

  If the harmonics generator ("Domain FREQ", "Shape FILE") is synchronized to the FFT analyzer, a highly accurate real-time frequency analysis can be performed. (see 2.6.7.3 Fast Frequency Response Measurement).

4. Optimizing the Speed of Generator Sweeps

- To perform a frequency sweep 'Sweep Mode' (in analyzer panel) should be set to FAST or BLOCK - if available.

  On certain conditions sweep velocity can be considerably increased:

  – Selection of generator function SINE
  – Use of universal generator, that is Low Dist OFF
  – automatic frequency sweep without Z-sweep, that is X-Axis FREQ, Z-Axis OFF

- Selecting the universal generator instead of the low-distortion or analog auxiliary generator

  Since the universal generator is superior regarding frequency setting time and frequency accuracy than the low-distortion generator it should preferably be used as a sweep generator. The low-distortion generator should only be used if its wide frequency range and excellent distortion and S/N ratio are required.

- Deactivating equalization of generator signal (SINE and DFD)

  With activated signal equalization the level has to be reset each time the frequency is changed. This extends the total setting time and thus the sweep time. For this reason equalization should be switched OFF in the case of very fast sweeps (see 2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM).

- Synchronizing the generator to the analyzer (next step ANLR SYNC)

  When the UPL generator and analyzer are used together, a generator sweep should always be synchronized to the analyzer. Thus it is ensured that the generator is switched exactly at the time when all measurement results are available (i.e. also frequency and input on the active channels, if required).

  DWELL should only be used together with an external analyzer (see 2.5.4.2 Sweeps).

- Manual selection of generator level range (only for analog level sweeps using the universal generator)

  When a reduced dynamic range can be accepted for the generator, selection of the fixed generator level range and generator setting time as well as the settling time can be shortened (see 2.5.2 Configuration of the Analog Generator).

- Reducing the measurements at low frequencies (particularly for RMS, RMSSEL and THD+N)

  ==> linear instead of logarithmic spacing,

  ==> increasing the start or (in the case of a sweep "from top to bottom") the stop frequency.

  Low frequencies require longer measurement times. For this reason too many unnecessary sweep points should be avoided in the lower frequency range.

- Reducing the sweep points or increasing the spacing, list sweep

  The time required for a sweep increases linearly with the number of sweep points. Unnecessary sweep points should be avoided. In the case of a list sweep the individual sweep points can be spaced as required and sweep points may be concentrated at positions of interest without substantially increasing the total number of sweep points (see 2.5.4.2 Sweeps).

- Switching off the result display and the status information

  In the case of sweeps, the output of individual results in the result display is mostly unnecessary or even useless particularly when the results are indicated with a high update rate. The same applies to the status information. For this reason the two displays can be switched off (together). This elimination of the output time - irrespective of the required measurement time - is particularly noticeable in the case of very fast sweeps (see 2.15.5 Display Settings). The measurements can still be followed by means of the sweep curve or the bargraph display. The complete sweep list can be displayed in the graphics panel whenever required. (see 2.10.4 Display of Lists).

- Switching off the graphic cursor

  For most applications display and update of the cursor values are not required while running sweep. Only the terminated sweep is analyzed by means of graphic cursors. Therefore the graphic cursors can be switched off during the sweep run and so the sweep time can be reduced (see 2.10.2 Trace and Spectrum Display).

2.7 Analyzer Filters (FILTER Panel)

The FILTER panel has been devised for definition of the filters which can then be used in the ANALYZER panel. Before you can select a user-definable filter in the analyzer, you must, of course, create it in the FILTER panel.

Activating the FILTER panel:
UPL front panel: FILTER
External keyboard: ALT + T
Mouse: (repeated) click on the right panel name, until the FILTER panel is displayed.

If the FILTER panel is already visible on the screen, it can be activated also by actuating one of the TAB keys (repeatedly) or by mouse-click.
Advantage: The panel need not be established again.

Filter

For the functions

- RMS & S/N (rms measurement) → 3 filters possible
- PEAK & S/N (peak measurement), → 3 filters possible
- Q-PK & S/N (quasi-peak meas.) → 3 filters possible
- THD+N/SINAD (distortion measurement) → 1 filter possible
- RMSSEL (selective RMS measurement) → 1 filter possible
- FILTSIM (filter simulation) → 3 filters possible
- RUB & BUZZ (loudspeaker measurement) → 1 filter possible
- WAVEFORM (DIGITAL or ANLG22kHz) → 1 filter possible
- 1/3-OCTAVE → 1 filter possible

any desired filters from the filter selection window can be set in the ANALYZER panel. This window contains user-definable filters (the first 9) and weighting filters, which are referred to by their short names in the FILTER panel or by a name complying to the standard. You can select any desired filter (also several times) and assign to the ANALYZER measurement function.

The sum frequency response of all selected filters can be graphically displayed using the analyzer function FILTSIM (see 2.6.5.13).

2.7.1 Weighting Filters

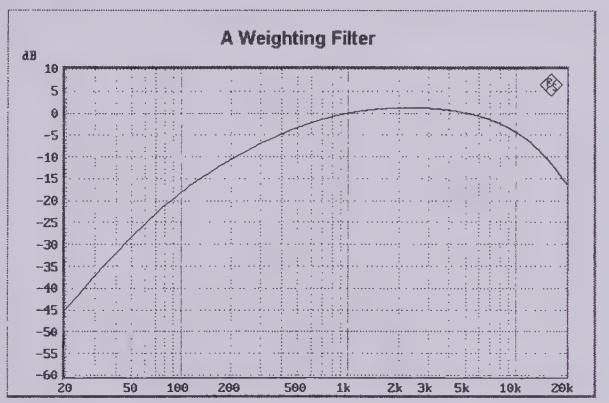
The user-definable filters in the UPL (see 2.7.2 Creating the User-definable Filters) are complemented by 13 pre-defined weighting filters, which are automatically matched to the current sample rate. Due to the digital realization, the frequency response absolutely complies with the standard. With a very small sample rate (e.g. 32 kHz in the DIGITAL instrument), some sections of the filter functions are close to the measurement range limit, resulting in distortions in these sections (with e.g. a sample rate of 32 kHz, distortions may occur in the range over 13.5 kHz). Yet, the filter is still within the permissible tolerances. For this reason, it is not possible to set weighting filters in combination with sample rates smaller than 30 kHz.

Note: *The weighting filters cannot be set in the filter panel, but are automatically available with the filter command of the respective measuring function.*

Filter: A Weighting

Standard(s): DIN 45412

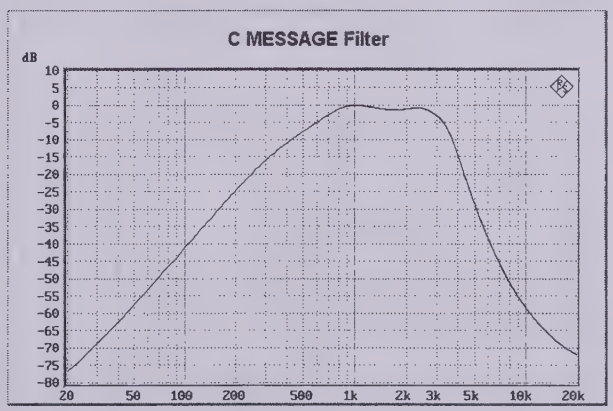
Application: Weighting for interference voltage measurements



Filter: C Message

Standard(s): IEEE 743-84

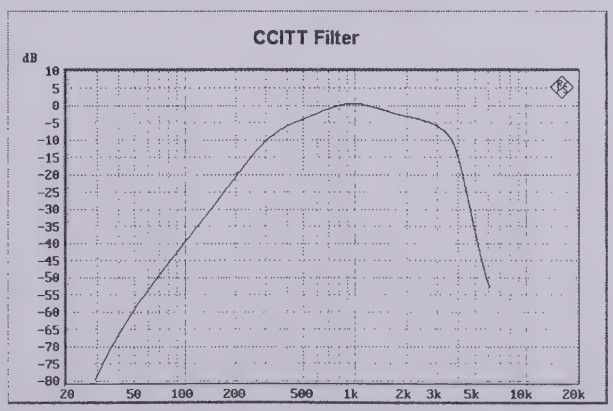
Application: Transmission measurements



Filter: CCITT

Standard(s): CCITT 0.41
IEEE Rec. 743-84
CISPR 6-76
CCITT Rec. P.53

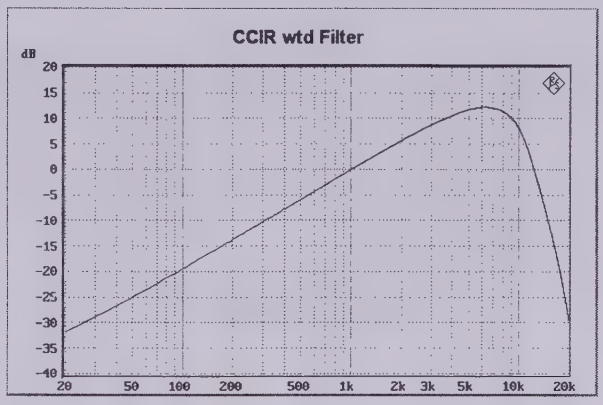
Application: Psophometric measurements



Filter: CCIR wtd

Normen: CCIR Rec. 468-4
DIN 45405
CCITT Rec. N21
CISPR 6-76

Application: Weighting for interference voltage measurements

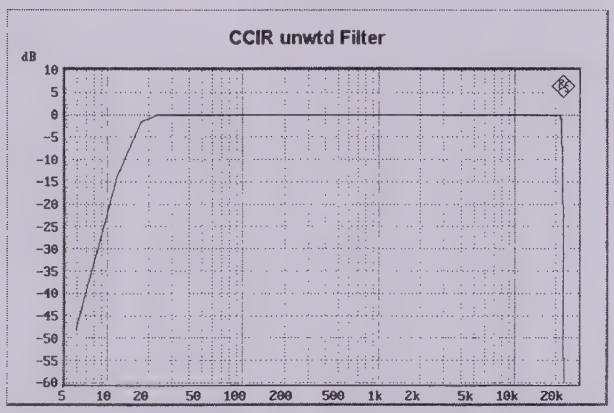


Filter: CCIR unwtd

Standard(s): CCIR Rec. 468-4

Application: Bandpass from 20 Hz to 20 kHz for band-limited, unweighted measurement to CCIR.

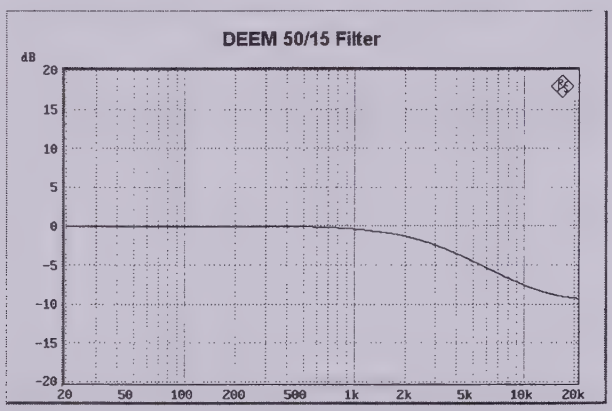
Note: Not available in analyzer 110 kHz



Filter: DEEM 50/15

Standard(s): CCIR Rec. 651

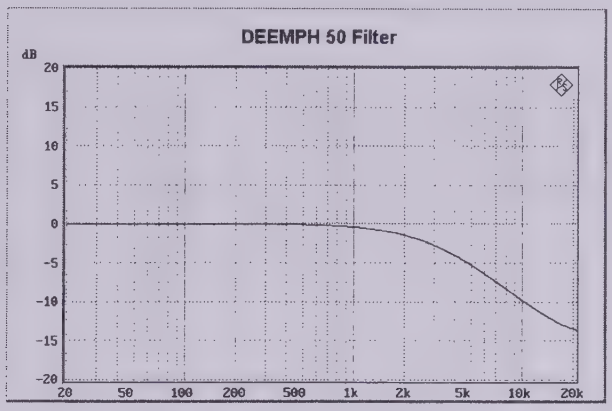
Application: Compact discs



Filter: Deemph 50

Standard(s): ARD Pfl.Heft 5/3.1

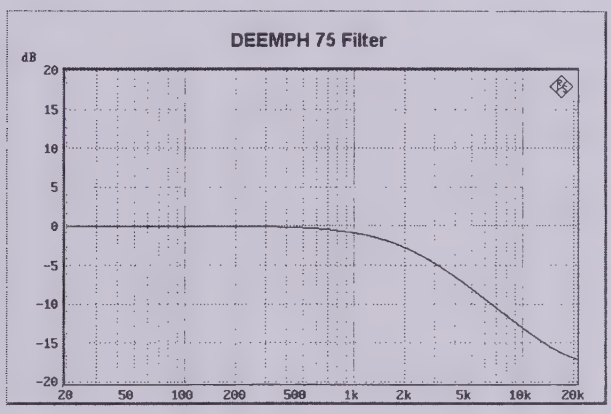
Application: Unweighted and weighted S/N measurements to DIN 45405



Filter: Deemph 75

Standard(s): same as Deemph 50

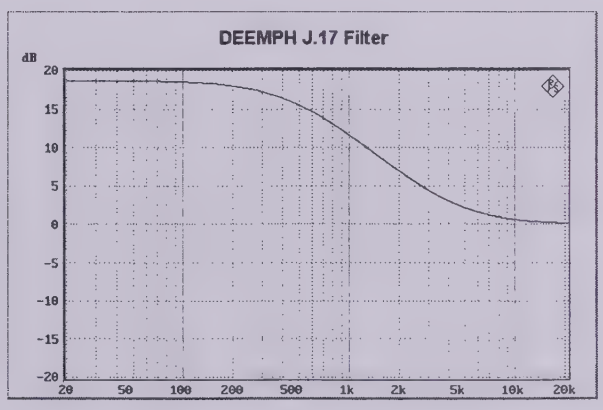
Application: Unweighted and weighted S/N measurements to DIN 45405



Filter: Deemph J.17

Standard(s): CCITT J.17

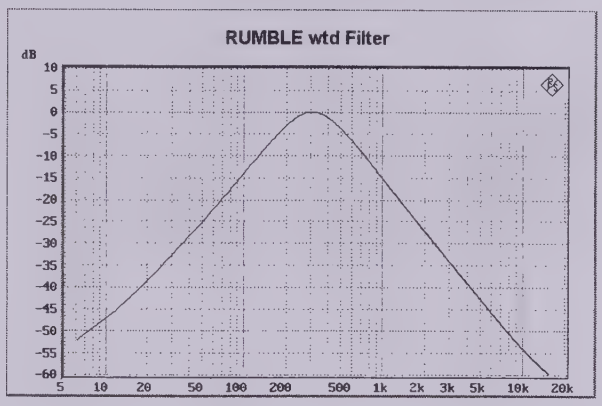
Application: Unweighted and weighted S/N measurements to DIN 45405



Filter: RUMBLE wtd

Standard(s): DIN 45539

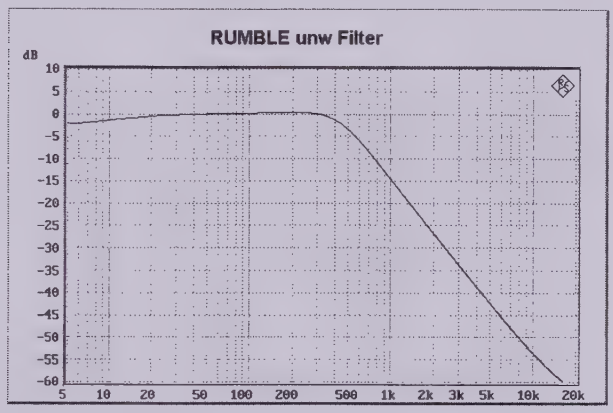
Application: Testing of record players
Weighted S/N measurements



Filter: RUMBLE unwtd

Standard(s): DIN 368.3
DIN 45539

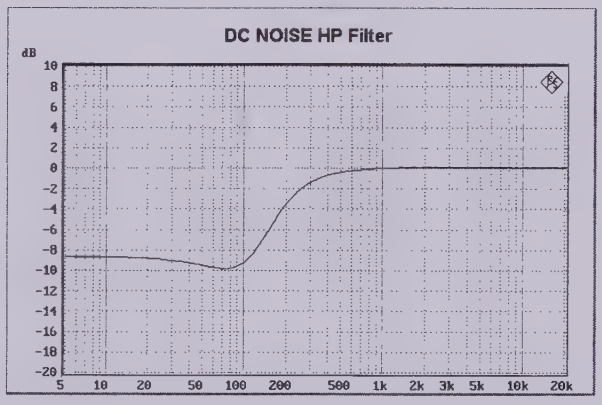
Application: Testing of record players
Unweighted S/N measurements



Filter: DC noise HP

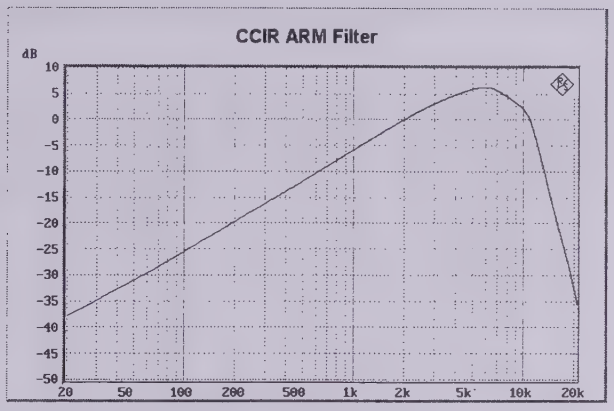
Standard(s): ARD Pfl. Heft 3/4
ARD Pfl. Heft 12/2

Application: Highpass for DC noise measurements (tape machines)



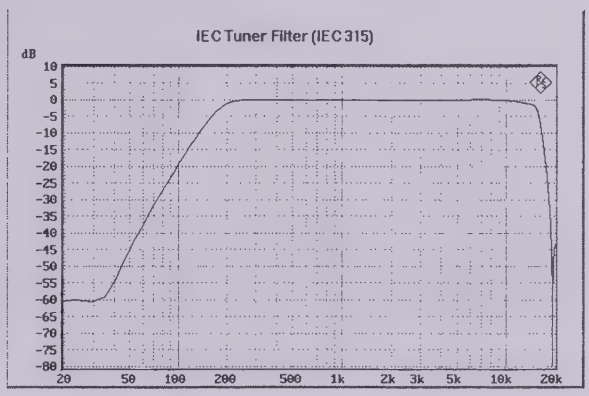
Filter: CCIR ARM

Standard(s): CCIR
DOLBY
NAB Standard



Filter: IEC Tuner
Standard: DIN/IEC 315

Application: Measurement on tuners



Filter JITTER wtd
Norm: AES 3

Application: Bewertung der Jitter-Übertragungsfunktion

2.7.2 Creating the User-definable Filters

The FILTER panel is made up of 9 filter positions designated as FILTER 01 ... FILTER 09. Each filter position can be assigned a filter of type LOW-PASS, HIGH-PASS, BAND-PASS, BAND-STOP, NOTCH, 1/3 OCT FLT, OCTAVE FLT, FILE-DEF, which are referred to below. Each filter type is predefined by its cutoff frequencies and the desired filter attenuation. After the filter has been calculated, further filter data (settling time, actual attenuation, stopband range, which are displayed in a different color) are available in the FILTER panel.

There is also the possibility of reading in any desired filter by selecting "FILE DEF".

Any filter defined in the FILTER panel is provided with a short name, which is then used to call the filter in the ANALYZER panel. The short name refers to type and cutoff frequency of the filter.

The filters have been implemented as recursive filters (=IIR filters) with 8 poles.

The filters are defined in terms of their frequency limits, which is why the contents of the FILTER panel is independent of the selected ANALYZER instrument ANLG 22 kHz, ANLG 110kHz or DIGITAL. Filter parameters which used to make sense for a certain instrument may be futile in combination with another instrument.

Example:
A lowpass with a cutoff frequency of 50 kHz is a commonly used filter with the ANALYZER instrument ANLG 110kHz, however ineffective in the instrument DIGITAL or ANLG 110kHz.

For this reason, proceed in the following order when setting the filters:

1. Switch all filters in the ANALYZER panel off:
   Enter any desired filter parameters in the FILTER panel. The filter parameters are neither checked nor updated.
2. In the ANALYZER panel, select a filter from the FILTER panel: now, the parameters of the filters are checked:
   a) Valid filter parameters: filter is set
   b) Invalid filter parameters: error message on the screen, filter remains OFF
3. Try to modify in the FILTER panel filter parameters of a filter selected in the ANALYZER panel:
   A dialog window appears where you can enter the new filter parameters. When you press the O.K. key in the dialog window the filter parameters are checked.
   a) Valid filter parameters: filter is set
   b) Invalid filter parameters: error message on the screen, the dialog window remains open for further entry of filter parameters.

Exiting the filter dialog window using CANCEL or ESC causes

- the filter in the ANALYZER panel to be switched OFF.
- the most recently valid filter parameters to remain unchanged in the FILTER panel.

Note: *A certain type of filter can be repeatedly assigned with the same or different filter parameters to the 9 filter positions!*
The sum frequency response of the set filters can be displayed with the help of the simulation (see FILTSIM function).
You can select the filters in the ANALYZER panel in any desired order. For reasons of stability, it is however useful to select the filter with the "hardest" characteristics (e.g. very narrow bandstop filters) as the last one (below in the panel).
It is possible to superpose several filters of the same type and with equal filter parameters for one measurement function. To give an example, a very steep 80-dB lowpass (in this case, with 16 poles, yet double ripple in the passband range) can be realized by superposing two 40-dB lowpasses.

2.7.2.1 Common Parameters of All Filters

Atten

(=Attenuation). Specify the desired filter attenuation in dB (example: 40 dB). After the filter has been checked and set, the actually realized attenuation (usually higher) is entered. Filter attenuations can be implemented about every 10 dB.

Exception: *The filter calculation file (see 2.7.2.6 Internal Calculation of Filters) has been modified.*

Delay

(Read only)
Enter the estimated settling time of the filter in seconds.
This value is updated only when the filter is checked.

Exception: *File-defined filters. Subsequent to entry of the coefficients, the software calculates a delay and enters it in the menu line where it can be modified manually.*

Shortname

(Read only)
Specify a short name used later to call the filter in the ANALYZER panel. The short name is made up of an abbreviation (2 letters) for the filter type and the frequency (LP = lowpass, HP = highpass, BP = bandpass, BS = bandstop, TZ = third-octave filter, OC = octave filter, NO = notch filter).

2.7.2.2 Lowpass / Highpass

Filter

Select a lowpass or highpass.

LOW PASS

HIGH PASS

Order

Specifies the filter order

4
8

By reducing the filter order from 8 (standard) to 4, faster but less steep filters can be created. The order can be determined separately for each highpass or lowpass filter.

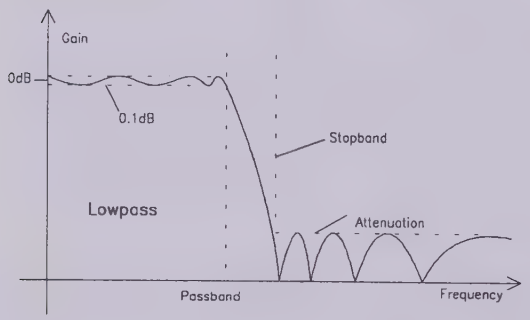
Passband

Specify the cutoff frequency of the passband range.

Stopband

(Read only). Display of the cutoff frequency of the stopband range, which is determined by the selected attenuation and passband range. This value is updated only when the filter is checked.

The basic filters used have eight poles, 'elliptic c'-type to /SAAL 88/ with a ripple of 0.1 dB in the passband range.



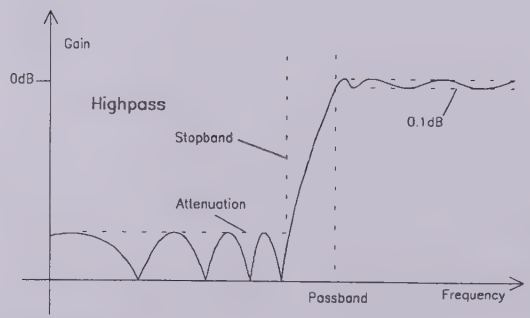


Fig. 2-33 LOWPASS and HIGHPASS frequency response together with filter parameters

2.7.2.3 Bandpass / Bandstop

Filter

BAND PASS

BAND STOP

Passb Low Enter the lower cutoff frequency of the passband range.

Passb Upp Enter the upper cutoff frequency of the passband range.

Stopb Low (Read only)
Display of the lower cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

Stopb Upp (Read only)
Display of the upper cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

The basic filters used have 4 poles, 'elliptic C'-type to /SAAL 88/ where one basic filter is used for the upper and one for the lower filter edge. As 'elliptic C' has a pole at infinity, a bandstop of this type features a pole in the center between the two passband frequencies.

Values for Passbd low and Passbd upp which are close to each other cause long settling times during realization and the danger of limit cycles (oscillations of the filter on account of self-excitation induced by rounding noise). In this case, it is useful to simulate the filters before the measurement (see analyzer function FILTSIM).

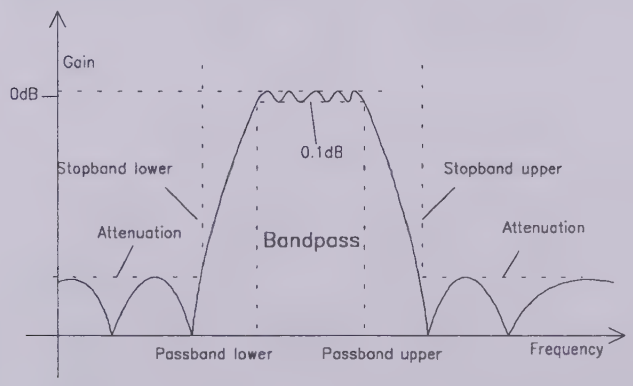


Fig. 2-34 BANDPASS frequency response together with filter parameters

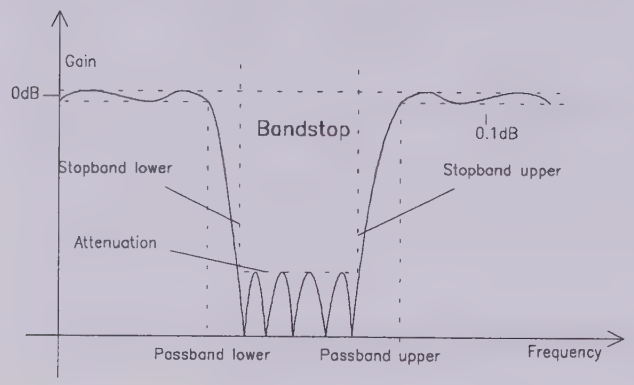


Fig. 2-35 BANDSTOP frequency response together with filter parameters

2.7.2.4 Notch

Filter

NOTCH FLT

Center Freq Enter the center frequency of the bandstop.

Width Enter the difference between upper and lower cutoff frequency of the passband range.

Stopb Low (Read only)
Display of the lower cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

Stopb Upp (Read only)
Display of the upper cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

The basic filters used have 4 poles, 'elliptic C'-type to /SAAL 88/ where one basic filter is used for the upper and one for the lower filter edge. As 'elliptic C' has a pole at infinity, a bandstop of this type features an attenuation pole at the center frequency.
Use:
Attenuation of single frequencies in the signal.

Small values for "width" cause long settling times during realization and the danger of limit cycles (oscillations of the filter on account of self-excitation induced by rounding noise). In this case, it is useful to simulate the filters before the measurement (see analyzer function FILTSIM).

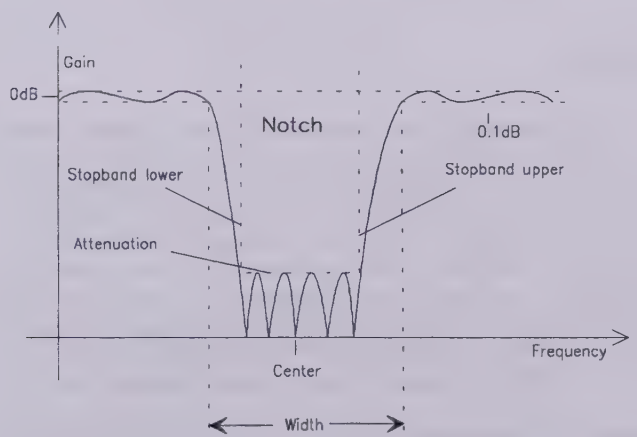


Fig. 2-36 Notch filter frequency response together with filter parameters

2.7.2.5 Third-octave / Octave

FILTER

1/3 OCT FLT

OCTAVE FLT

(1/3 OCT FLT = third-octave filter)

Center Freq Enter the center frequency of the bandstop.

Width (Read only)
Enter the difference between upper and lower cutoff frequency of the passband range.

These filters have been implemented as bandpasses (see 2.7.2.3 Bandpass / Bandstop) which are geometrically symmetrical to the center frequency, thus allowing the passband cutoff frequencies to be calculated from the center frequency:

1/3 octave filter:	Passbd low	= Center Freq / 1.12246
	Passbd upp	= Center Freq x 1.12246
Octave filter:	Passbd low	= Center Freq / 1.41421
	Passbd upp	= Center Freq x 1.41421

Note: *For these filters the 0,1dB-bandwidth is reduced in order to obtain an attenuation of 3 dB at the cut-off frequencies. Hence the effective bandwidth is lower than the theoretical values of third octave and octave filters.*

theoretical bandwidth third octave: $\sqrt[6]{2} - \frac{1}{\sqrt[6]{2}} = 0.2315 = 23.15\%$

theoretical bandwidth octave: $\sqrt[2]{2} - \frac{1}{\sqrt[2]{2}} = \frac{1}{\sqrt{2}} = 0.7071 = 70{,}71\%$

2.7.2.6 Internal Calculation of Filters

All filter parameters are transformed from the Z range (digital, sampled) to the s range (analog, continuous) using the sample rate valid for the respective instrument. In the s range, the filter parameters are normalized to a passband limit of 1.0. The filter suitable for this transformed filter with respect to the type (i.e., elliptic c and eight-pole for highpasses and lowpasses and four-pole for bandpasses) and minimum desired attenuation is searched for in the filter data base. This filter is then denormalized and retransformed while the actual stopband and actual attenuation are being calculated. This transformation is performed with the currently effective sample rate. The predefined cutoff frequencies are maintained, however different stopband frequencies will be obtained (depending on the selected sample rate). When the sample rate on which the calculation is based does not match the actual clock rate (e.g. in the case of a wrong entry), both passband frequency and stopband frequency are shifted.
After the start of the measurement (e.g. through a new setting, pressing of the START key or in the case of SWEEP), UPL waits for a certain settling time per filter before the actual signal integration. This settling time is calculated on the basis of the desired attenuation and the filter coefficients. If (in exceptional cases) the time calculated is too small, the filters have not completely settled at the start of the measurement.
To remedy this, the following trick is possible:

If the FILE_DEF filter "DELAY.COE" is selected, a settling time can be entered there which is considered in addition to the normal settling time in the measurement. Filter DELAY.COE has no function otherwise.

The filter data base is filled with the filters in the 'ref–lp.rlp' file in the C:\UPL\REF directory on start of the system software.

The filters contained in this file are derived from /SAAL 88/. Their ripple in the passband range is 0.1 dB.

***Note**: For the ANLG 110 kHz analyzer a reference lowpass filter of 74 dB and with 0.03 dB ripple is used for the RMS selective measurement.*

2.7.2.7 File-defined Filter ("FILE-DEF")

For applications requiring additional filters which are not offered by the instrument, any desired filter can be read in from a file. The filter in the file must be an IIR filter with 8 poles/zeros. The filter must be designed (in the Z range, i.e. digital, sampled) with reference to the sample rate used in the respective ANALYZER instrument. Two data formats are supported:

a) **Coefficient output file of FDAS**, version 2.1 and 2.2. FDAS is a filter design program from the company of Momentum Data Systems. Select a cascade of biquads with 32-bit float number representation as implementation for generation of the filter with the help of FDAS.

   Example: see R&S–EXAM.COE file in the C:\UPL\USER directory

b) **ASCII file** where the poles and zeros (in the z level) must be entered as floating numbers. 8 poles and zero positions (4 pairs) only are permissible. Unused poles and zeros must be shifted to the origin of the z level.

   File format:

1st line:	Identification: 'pole zero file'
2nd line:	Key word 'gain' followed by a float number: specification of filter gain
following lines:	Key word 'pole' or 'zero' followed by real and imaginary part. Complex conjugate pairs must be consecutive and be at the 1st, 3rd, 5th or 7th position, respectively.

   The transfer function is given by:

$$S(z) = gain * \frac{\prod_{i=0}^{3}(z - z_{oi})*(z - z_{oi}^*)}{\prod_{i=0}^{3}(z - z_{pi})*(z - z_{pi}^*)}$$

   where S(z) is the normalized transfer function, z_0 are zeros and z_p are poles.

   The filter should be checked using the simulation.

   Comment lines should begin with '#' and are permissible anywhere; no difference is made between upper-case and lower-case letters.

   Example: see R&S_EXAM.ZPZ file in the C:\UPL\USER directory

Literature:

/SAAL88/: Rudolf Saal, Handbook of Filter Design, 2nd edition, Hüthig 1988

2.8 STATUS Panel

Activating the STATUS panel:

UPL front panel: STATUS
External keyboard: ALT + S

The STATUS panel can be activated only in part-screen graphics mode (see 2.10.9 Switching between Full-screen and Part-screen Mode) and is always on the left side of the screen.

The STATUS panel displays only those command lines of a panel which have been ticked (select the position before the line using the tab ← keys, press SELECT, the tick is switched on and off (toggle function). The UPL thus offers the possibility of displaying a clearly structured excerpt from all settings on the left side of the screen.

Instead of using the other panels, the UPL can also be operated from the STATUS panel, allowing you to carry out constantly recurring operator sequences from one panel only. Use of the STATUS panel is especially advantageous for display and, if required, printout (see 2.14) of graphics on the right side together with the essential UPL settings on the left side of the screen.

Empty STATUS panel.
No command lines have
been ticked off.

Command lines in the GENERATOR,
ANALYZER and DISPLAY panel
have been ticked off.

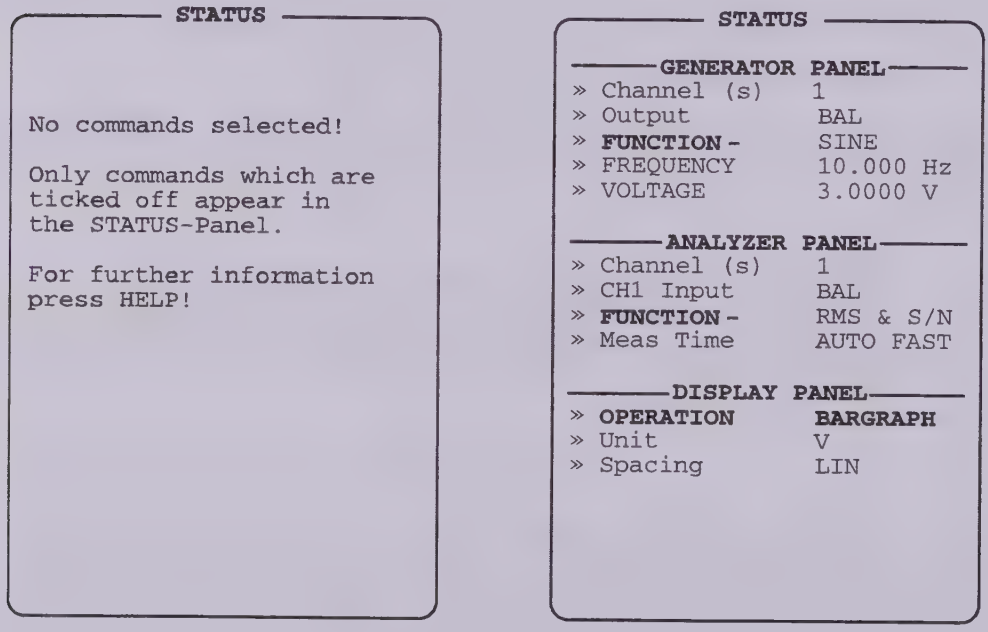


Fig. 2-37 Status panel

2.9 Series of Measured Values, Files and Loadable Instrument Settings (FILE Panel)

The FILE panel is activated by pressing the FILE key (UPL front panel) or the key combination "ALT F" (external keyboard). The FILE panel is always displayed on the left side of the screen.

2.9.1 Loading and Storing

Files can be stored to hard disk (drive "C:") or floppy disk (drive "A:"). All system files are available on hard disk and, in the default setting, the user files too. The user files can also be written to or read from diskette.

UPL system software updates are also loaded from diskette (see 1.3 Software Installation). For storing files on diskette, DOS- formatted 3.5" diskettes are required. Unformatted diskettes can be formatted on operating system level using the command

```
FORMAT A:
```

An external keyboard is required for this purpose.

Insert the diskettes into the drive with the metal slider pointing to the front and the label to the left. The diskette is ejected by pressing the eject key.

On the left side of the diskette, there is a lockable write protection; the disk is write-protected when the hole is free.

The individual types of files are characterized by reserved file types (file extensions), which are listed in the table below. It also provides information on where, i.e. in which panel, the file is loaded.

Table 2-35 Meaning of file extensions

Extension	Meaning
.AES	Report information AES/EBU+S/P DIF
.BAT	Batch file for automatic execution of several programs; reserved (DOS)
.BPZ	Binary file with poles-zeros
.CAL	Calibration file; reserved for calibration factors
.COE	Coefficient file for filters (see 2.7.2.7)
.COM	Executable programs; (e.g. BIOSW.COM); reserved (DOS)
.DWL	Dwell time for automatic generator sweeps: loaded in the GENERATOR panel, menu item "Dwell List"
.ERR	Error file for limit violations loaded in the DISPLAY panel by selecting Trace A/B→FILE; OPERATION→LIM REPORT;
.LOG	Prolog and epilog for HPGL (see 2.14 Printing / Plotting / Storing the Screen Contents (OPTIONS Panel))
.PLT	Colour palette information for PCX and printer (see 2.14 Printing / Plotting / Storing the Screen Contents (OPTIONS Panel))

Extension	Meaning
.EXE	Executable programs; (e.g. UPL_UI.EXE); reserved (DOS)
.FTF	Amplitude/frequency table for generation of noise in the frequency domain (see 2.5.4.11)
.GL	Screen hard copy (Destin HPGL file) is generated in the UPL for subsequent output to a HPGL printer
.HLP	Help file
.LLW	Limit curve (LOWER) loaded in the DISPLAY panel under the heading LIMIT CHECK, "Lim, Lower" menu item "File name"
.LUP	Limit curve (UPPER) loaded in the DISPLAY panel under the heading LIMIT CHECK, "Lim, Upper" menu item "File name"
.NPZ	reserved for filters
.NRM	Normalization file reserved for filters
.OUT	DSP files reserved for programs to be down-loaded to the DSPs
.PAC	Protocol analysis (AES/EBU, SP DIF), screen control file for channel status data
.PAU	Protocol analysis (AES/EBU, SP DIF), screen control file for channel status data
.PCX	Screen Hard Copy (Destin PCX file) generated in the UPL to be copied to other programs
.PGC	Protocol generation (AES/EBU, SP DIF), user data, file for channel status data
.PGU	Protocol generation (AES/EBU, SP DIF), user data, file for channel status data
.PPC	Protocol generation (AES/EBU, SP DIF), user data, file for user-definable PROTOCOL panel
.RLP	Reference lowpass (reserved for filters, see 2.7.2.7)
.SAC	Partial setup; loaded in the file panel under the heading LOAD INSTRUMENT, menu item Mode→ACT SETUP
.SCO	Setup; loaded in the FILE panel under the heading LOAD INSTRUMENT, menu item Mode→COMPL SETUP
.SPV	Sweep list for generator voltage loaded in the GENERATOR panel, menu item "VOLTAGE" or "TOTAL VOLT" (depending on the function) for X- or Z-axis sweep
.SPF	Sweep list for frequency of the generator or selective rms measurement; loaded in the GENERATOR panel, menu item "FREQUENCY", "MEAN FREQ" or in the ANALYZER panel, menu item "File name" for X- or Z-axis sweep
.SPO	Sweep list for burst duration loaded in the GENERATOR panel, menu item "ON-TIME" for X- or Z-axis sweep
.SPI	Sweep list for burst interval loaded in the GENERATOR panel, menu item "INTERVAL" for X- or Z-axis sweep
.TRC	Trace lists for recording of measured values loaded in the DISPLAY panel by selecting Trace A/B→FILE
.TTF	Time table for generation of arbitrary signals (see 2.5.4.10)
.VEQ	Equalizer file loaded in the GENERATOR panel, menu item "Equal File" or as RANDOM Freq-File
.ZPZ	Pole-zero file reserved for filters
.CFG	File with control instructions for working directories

Note: *Reserved files must not be changed or renamed.*

2.9.1.1 Loading and Storing of Instrument Setups and Complete Setups

Setups are loaded and stored by entering a file name in menu item "Filename". If the desired file name is already in the menu line, one simply has to open and close the appertaining selection box. (see 2.3.2 Data Entry).

LOAD INSTRUMENT STATE Loading an instrument setup

Mode	Selection of setup to be loaded
DEFAULT	(Default setup) The Rohde&Schwarz *default* setup (see 3.5) is to be loaded. This includes all presently inactive functions and instruments. A change of this setup is not recommended but possible by overwriting the DEFAULT.SET file by a setup stored under the COMPL SETUP mode.
COMPLETE	(Complete setup) The *complete* instrument setup is to be loaded. This includes all presently inactive functions and instruments as well as the comments that can be entered for a hardcopy (see **2.14.1 Screen copy to** printer (pixel-oriented)). Under this item only **complete setups** (with any file extension, for instance *.SET) can be loaded.
ACTUAL	(Actual setup) The *actual* instrument setup (with or without measured values and curves) is to be loaded. Loading a current setup does **not** affect inactive instruments and functions. Under this item only "**Actual Setups**" and "**Actual +Data Setups**" (with any file extension) can be loaded; the latter contain additionally measured values and measured curves and therefore require a longer total loading time especially when the curves have to be displayed.
SETUP	An instrument setup is to be loaded. The type of setup (actual or complete) is identified by means of the file extension. Under this item any setup with the file extension ***.SAC or *.SCO** can be loaded; other extensions are not permissible.

STORE INSTRUMENT STATE Storing an instrument setup

Mode

Selection of what is to be stored.

COMPLETE

(Complete setup)

The *complete* instrument setup is to be stored .
This includes all currently inactive functions and instruments and all comments that can be entered for a hardcopy (see **2.14 Printing / Plotting / Storing the Screen Contents (OPTIONS Panel)**). A file with the extension .SCO occupies about 80 Kbytes of mass storage.

ACTUAL

(Actual setup)
The *actual* instrument setup is to be stored. This includes all currently active instruments and functions. A file with the extension .SAC occupies about 8 Kbytes of mass storage.

ACTUAL+DATA

(Actual setup including data)
The current instrument setup *including measured values* and *curves* is to be stored. The required storage capacity depends on the size of the active traces.
The measurement or sweep should be TERMINATED prior to storage to make sure that valid measured data are available.
If only measured values (without *curves*) are to be stored, the traces in the display panel must be switched OFF.

Note: *If valid measured* ***curves*** *are available, this type of setup requires considerably more memory capacity (up to 100 Kbyte) and longer loading times than the actual setup. For this reason, this type should only be used when the curves are really needed.*

When loading a new instrument setup, the previous setting is overwritten. All lists (equalizer, limits, etc.) are filled with files the names of which are contained in the new setup. If a file cannot be loaded (e.g. the specified equalizer file has been cleared), an error message is generated and the file name is entered into the menu line as the error source.

Note: *When loading setups, their file names may not exist (e.g. because they have been deleted or the setup has been adopted from another UPL). In such cases, the cause of error (usually "not found") is stated below the respective entry (e.g. "File name").*

Attrib

(Attributes); For storing only.

READ ONLY

The stored file is write-protected.

READ/WRITE

The stored file can be deleted or overwritten.

Deleting a write-protected file requires the R attribute to be deleted using the DOS command ATTRIB at the operating system level.
Syntax: `ATTRIB -R file name`
The use of an external keyboard is necessary for this purpose. It is therefore recommended that the write protection be used only when a setup is not to be changed.

Info Disp

(Info display), is displayed when the setup is *loaded* (LOAD INSTRUMENT STATE).

A comment with a maximum of 39 characters can be entered in each setup in the FILE panel under the menu item "Info Text" for a more detailed description of the measurement task or the like. When loading a setup, this comment can be displayed via the file selection window so that the purpose of the setup is known before it is actually loaded.

OFF

The "Info text" of a selected setup is not displayed, scrolling in the file selection window is possible at maximum speed.

Note: *When a floppy is to be accessed (drive A:), the info display should preferably be switched off as otherwise scrolling in the file selection window would be considerably slowed down because of the long access times required for opening floppy files.*

ON

The info text for the selected setup is displayed in the user info line. Since the info text has to be read out of every setup, scrolling in the file selection window is slightly slowed down.

Info Text

Indicated when a setup is *stored* (STORE INSTRUMENT STATE).

Entry of a comment of maximum 39 characters for a more detailed description of the measurement to be performed, the DUT or the like. When a setup is *loaded,* this comment can be displayed via the file selection window (see "Info Disp").

Filename

Causes a file with the specified name to be loaded or stored.

If the file cannot be opened, an error message and "not found" is entered in the menu line.

For entering file names, see 2.3.2.5.

2.9.1.2 Loading and Storing of Series of Measured Values and Block/List Data

Series of data from recorded sweeps and/or FFTs, waveform data or filter simulation data can be stored in a file for several purposes:

- To load them at a later date as a record, for the purpose of comparison or subsequent processing. The series of measured values are loaded using the DISPLAY panel commands and are displayed in the form they were stored. They can however be provided with a different scaling or converted into other units.
- The files can be called from other programs and their data further processed. This is most appropriately done using the ASCII format. The structure of an ASCII file is shown in some examples (R&S_EXAM.TRC in the C:\UPL\USER directory), which are provided with detailed comments. Refer to Section 2.9.1.3 Format of the Block/List Files for more detailed descriptions.
- Stored traces can be used in the UPL for several purposes: As reference traces for other traces if the results are displayed in relative units. For this, the stored traces are loaded by means of FILE under Reference in the DISPLAY panel. Moreover, the trace files can be used to provide equalization data for the generator.

The data are stored in files using commands in the FILE panel (also see 2.3.2.5 Entry of File Names). A series of measured values (Y or Y2) and its associated X-axis values are stored by means of Store TRACE A or TRACE B. If a variable reference value (i.e. a reference value as a function of the X-axis) and a relative unit (i.e. a unit needing a reference) are active, the reference values too are stored in the file. If a Z-axis sweep is selected in the generator, the Z-axis values too are stored. The entire scaling information as well as the function labeling are appended in coded form. If User Label is switched to on in the DISPLAY panel, user-defined function labels and units are also stored.

With command Store TRACE A + B, the data of the second series (trace B with the scaling of Y2) are stored, too, with their associated reference values. The corresponding format can be loaded as a dual trace by means of DUAL FILE in the DISPLAY panel. If Scan count >1 in the DISPLAY panel is active, which is always the case with Z-axis sweeps, the above series of measured values are stored not as one but as several scans. Scan groups too can be loaded from the DISPLAY panel as a unit (see 2.9.3.3 Scan Count >1).

The files are loaded for the functions they are needed. In the GENERATOR panel, for example, the sweep, dwell, and equalization files are loaded. Sweep and dwell files are also used in the analyzer mode for selective rms measurements. In the DISPLAY panel, traces (from sweeps or FFTs), reference traces (for sweeps) and limit-value files (limit files) are loaded.

All measured values are stored with their basic units: levels in V, frequencies in Hz, times in s, phases in degrees, related quantities in %. Notice that S/N data - such as S/N levels - have to be indicated in positive dB values, i.e. 0 dB is 100%, 20 dB means 1000%, the numerical value being 1000.

Store traces and sweep lists

Store TRACE/LIST

During a sweep, various buffers are created for sweep parameters, measured values, limit exceedings and waiting times, if any. This menu item serves to select which one of these buffers is to be stored.

TRACE A
TRACE B

Store the TRACE A or the TRACE B buffer; (specify in the DISPLAY panel which measured values are to be collected in which trace buffer) (see 2.10.1 Parameters for Display of Traces and Spectra). In addition to the trace data, the values of the appropriate X-axis as well as the values for scaling from the display panel are stored to permit the curve to be displayed as it was scaled in storing.
If a variable reference and a relative unit are used, the corresponding reference trace is stored too. If Scan count >1 is selected in the DISPLAY panel, a group of traces, or pair of traces, determined by Scan count is stored in the file (with reference traces, if applicable).

TRACE A+B

A pair of traces (or a group of pairs of traces if Scan count is set to >1) is stored in a file. The pair(s) of traces can be loaded as a unit by means of DUAL FILE under TRACE A.

Note: *When storing traces, also the X axis and in the case of a 2-dimensional sweep the Z axis are stored.*
For an assignment to the sweep parameter see X Axis and Z Axis in the GENERATOR panel (see 2.5.4.2 Sweeps). The list formats (file types) can be seen from the table in section 2.9.1.

X AXIS

Store the list with the sweep points for the sweep parameter lying on the X-axis (for generation of lists used in the list sweep).
For the generation of a sweep list, proceed as follows:
GENERATOR panel

- Activate the sweep system ("Sweep Ctrl → AUTO SWEEP")
- Set the X-axis to the desired parameter (e.g. FREQ for the frequency sweep list)
- Select the start and stop values as well as spacing of the desired parameter (recommended: LIN POINTS or LOG POINTS)
- Enter the number of sweep points, which determine the number of entries in the sweep list generated later.

Start the sweep by pressing the START key. When the sweep enters the SWP ... RUNNING state, the sweep list is available; the sweep can be aborted.

Generating or modifying sweep lists is also possible using a text editor (e.g. EDIT from DOS).

Z AXIS

Store the list with the sweep points for the sweep parameter lying on the Z-axis (with two-dimensional sweep only, for generation of lists used in the list sweep).

For generation of the Z-sweep list, it is advisable to proceed as described under generation of the above-mentioned X-list, however, set the values for the Z-axis in the GENERATOR panel.

Generating or modifying sweep lists is also possible using a text editor (e.g. EDIT from DOS).

Store

DWELL VALUE

For sweeps with time synchronization only; store the buffer for the dwell time. The time data are obtained either from a file (with list sweep) or they are all equal (with Next Step DWELL). The dwell time or the file name for the active dwell list is entered in menu item "Dwell" or "Dwell List" in the GENERATOR panel (see 2.5.4.2 Sweeps).

LIM UPPER
LIM LOWER

The upper or lower limit curve (tolerance mask) is stored to file.
When a limit curve is loaded as is described in Section 2.10.7 Limit Check, a list of all interpolated X-Y pairs is output.

EQUALIZATN

Equalization)
Special case: store the frequency response of a device under test, e.g., as equalization file, which can then be read in for frequency-response compensation purposes

- in a sweep with a generator sinewave signal under menu item "Equal. file" in the GENERATOR panel
- or as generator RANDOM function with Domain FREQ and Equaliz FILE.

For this purpose, the inverse frequency response normalized at any frequency can be stored (see menu item Norm Freq or Invert 1/n). The measurement data (frequency response) must be provided in one of the trace buffers, which can be selected under menu item "Volt sourc".

For generation of an equalization file, proceed as follows:
Connect the DUT to channel 1 and select this input/output in the generator and the analyzer. The generator is set to a frequency sweep using „FUNCTION → SINE" (cf. 2.5.4.2 Sweeps). In the analyzer, the swept voltage of the DUT is determined using the function RMS & S/N. Entry of TRACE A → FUNC CH1 in the DISPLAY panel fills the trace buffer A, which is then referred to as data source for the equalization file using the command Voltsource → TRACE A described below. Prior to storing the equalization file by entry of file name, the user should enter a standard frequency (e.g., 1 kHz) and Invert 1/n ON.

Data obtained by filter simulation can also be converted into an equalization file. To this end select the function → FILTERSIM and set TRACE A → FUNC CH1 in the DISPLAY panel. In contrast to the above-mentioned file-generation, neither a sweep must be performed nor the DUT connected.

LIM REPORT

(Limit report)
Stores the list of limit violations. With sweeps and FFT, 0, 1, 2 or 3 is entered into this error-report block. Information on how to interpret this code is given below. The limits or limit curves are indicated in the DISPLAY panel under menu items LIM UPPER and LIM LOWER (cf. 2.10.7 Limit Check).

Format

Select the file format.

REAL

Data are stored in binary format; rapid access.

ASCII

Data are stored in ASCII format, can be further processed using any text editor or other programs.

Voltsource

For Store → EQUALIZATN only.

TRACE A
TRACE B

The trace buffer specified here must be the one containing the measurement data; the ANALYZER and DISPLAY panels must be appropriately configured (see "Store → EQUALIZATN").

The voltage data are read from the trace buffer A/B.

Normfreq

For Store → EQUALIZATN only.

Specify the frequency on the voltage value of which is normalized. Selecting the frequency at which the frequency response curve has its maximum means that the equalization file contains values from 0 to 1 only. If any other frequency is selected, factors higher than 1 occur.

Invert1/n

For Store → EQUALIZATN only.

Inverting the frequency response causes, with the equalizer switched on, the device under test to get an equalized frequency response. Application: constant (independent of frequency response) outgoing power, pre-/ deemphasis

ON

The equalization curve is stored in inverted form.

OFF

The equalization file is not inverted.

Filename

Causes the trace or list to be stored under the specified file name.

If the file cannot be opened, an error message and "not found" is displayed in the menu line.

For entering file names, see 2.3.2.5.

2.9.1.3 Format of Block/List Files

Overview

The following text describes the format of the trace/list files, as it is used internally for storage of measured values and sweep, dwell, equalization and limit lists. This is of interest for the user only, if he wants to copy values into other programs, edit files or create new files for internal use. The subsequent description is intended to offer support in this case. You may additionally refer to the supplied example files (R&S_EXAM.*) in the directory \UPL\USER. These ASCII files contain comments and some of them are even available in various versions (e.g., R&S_EXAM.TRC, R&S_E209.TRC, R&S_E212.TRC).

Numeric data formats (ASCII and REAL)

All values are stored with their basic units. Physically useful values have an exponent between E 6 (120 dB or mega) and E-12 (-240 dB or pico). (They are converted with the units set for curve representation).

In contrast, numbers are interpreted as factors to the reference value for limit files (cf. 2.10.7 Limit Check).

Notice in advance the description of the differences between the REAL format (binary according to 4-byte IEEE Standard) and the readable ASCII notation. The advantage of the first format is the compact setup and fast access, since the numbers do not have to be converted. However, the user normally prefers using the ASCII format which is easier to handle.

In the REAL format, the numbers are not separated by a separator and they are arranged in successive blocks, e.g., all X-values first, succeeded by the Y-values. With multiscan data (cf. 2.9.3.3 Group of Curves) the X-values then come again, followed by the Y-values etc.

In the ASCII format, all data of an index are arranged in a printable line, the data are separated by a space character and the line is terminated by carriage return / line feed (called CR/LF in the following). Multiscan data are also arranged successively, in this format.

Up to version 211 of the file format, the ASCII numbers like the REAL numbers were arranged in blocks and all numbers were separated by CR/LF. If the previous format is continued to be used for reasons of compatibility, it can be generated by setting a call parameter. This parameter is -o8 and must be inserted in the AUTOEXEC.BAT subsequent to the line containing the UPL(bat) call using an editor on the DOS level.

Setup

Explanation of the file setup can be most clearly arranged in simplified Backus-Nauer form. The meaning of each individual line is explained in detail in the following.

```
file := header_struct, trace [,info_struct]

    trace := scan | multiscan | fft_scan

        fft_scan := y_block, x_def [, y2_block]
        multiscan := scan 0, count 1, scan 1 [, count n, scan n]....
        scan := ascii_scan | real_scan

            ascii_scan := ascii_sample 0,  [, ascii_sample n ]...
                ascii_sample := x, [, y [, ref] [, y2 [, ref2] ] ], „CR/LF“

        real_scan := y_block [, x_block [, ref_block] [, y2_block [, ref2_block] ] ]
```

x_block, y_block, ref_block, y2_block and ref2_block are blocks of REAL (IEEE 4- byte float). With fft_scan, y_block and y2_block may also be ASCII numbers separated by CR/LF.

x, y, ref, y2, ref2 are numbers in the ASCII notation, separated by spaces. CR/LF is appended to ascii_sample.

The ASCII format allows for inserting comments. They begin with '#' character and are terminated by subsequent CR/LF. Maximum 80 characters are permitted.

File

The first line explains that a trace/list file always consists of a header_struct and a trace of numbers, followed by an info structure, if desired. In the following, an individual chapter is dedicated to each of the above-mentioned key-words.

File header (header_struct)

The header is always stored in the ASCII notation and contains 7 integers (16-bit integer) with the following meaning:

```
###### beginning of header
#
213  # version of fileformat this file is built with
0    # format: 0 for ASCII, first all y values then all x values
#              1 for binary (ieee float), successive blocks like format 0
#              2 for ASCII, pairs of values, first y then x values
1131 # mode:   16 bit integer consisting of
#              3 bits (LSBits) comb: 1 for y only, 2 for x+y, 3 for x+y+z,
#              DSP data: 4 for fft, 5 for waveform, 6 for filtsim
#              1 bit new: true since sw vers 2.09
#              2 bits dual: 0:for mono, 1:dual with equal scale,
#                           2:dual with 2 scales
#              2 bits multi: 0:single, 1:multi scan (2, 3 unused)
#              2 bits ref_trc_a: 0 no reference or value
#                                1: reference trace on file
#                                2, 3 unused
#              2 bits ref_trc_b: like ref_trc_a
#              4 bits (MSBits) reserved
3    # scan count (of first scan if multi scan)
5    # count of entries for scan 1
1    # x scale: 0 for lin, 1 for log
0    # y scale: 0 for lin, 1 for log
#
#----- beginning of scan 1
```

- The **first number** contains the version number of the file format. All previous formats can be read from an updated software version but not vice versa, which is why an update of the instrument software is advisable.

- The **second number** indicates the format. 0 means an earlier ASCII format, which contained the figures in successive blocks similar to the sequence used by the REAL format. No further details will be given here. - 1 means that the following numbers are given in the REAL format. 2 stands for the previously described ASCII format with y and x values arranged in pairs.

- With the **third number**, the individual bits are assigned a meaning, each:

Bits 0 to 2 explain the data structure. Value

1 stands for one-dimensional row (e.g. sweep-list),

2 for two dimensions (e.g. x- and y-data),

3 for three dimensions (generally multiscan data with Z axis),

4 indicates two-dimensional data with fixed x-values (given by start and delta values), generally FFT data

5 like 4, but waveform data and

6 for filter simulation data.

Bit 3 is always set to one starting with version 209 and indicates that the subsequent data are also defined in the data structure described here.

Bits 4 and 5 indicate whether the trace is a mono trace (0) or a dual trace (1).

Bits 6 and 7 indicate single scan(0), multiscan (1), or multiscan with z-sweep (2).

Bits 8 and 9 indicate whether the y-axis contains a reference value (1) (thus, a y-data consists of 2 numbers) or not. If not, these bits are set 0.

Bits 10 and 11 have a similar meaning as bits 8 and 9, however, they refer to the second y-value (y2) with dual trace.

The remaining four bits have been reserved for extensions.

- The **fourth number** indicates Scan Count, the number of scans contained in this file.
- The **fifth number** represents the maximum index + 1, i.e., the number of x (or y, ref , y2, ref2) samples of a scan.

  Note that, with multiscan, each scan may consist of a different amount of x/y-data (e.g., with external sweep) which is why the current number of the following values is indicated before each new scan.

- The **sixth number** is a 0, if the X axis is linear, 1 stands for logarithmic scaling. For an interpolation of intermediate values of limit curves that are neither horizontal nor vertical, these values are used in the x and y direction. For a correct graphics display it is important for the file entries and the actual scaling to be in agreement, as the measurement points in the display are connected by a straight line. If the data do not match, bent curve sections (elliptic segments) are obtained in the calculation which are not drawn in the display and therefore not visible.

- The **seventh number** is similar to the sixth but refers to the Y axis.

Trace

The header, especially the third number specifies how to interpret the subsequent trace.

- One-dimensional
  The group of one-dimensional traces/lists (e.g., frequency list of a sweep) is simply a sequence of numbers, which is separated in the ASCII notation by CR/LF and directly successive in the REAL format. Bits 0 to 2 of the third number in the header are assigned the value 1.

- Two-dimensional

  The significant group of two-dimensional data (e.g., dwell, equalization, limit) contains pairs of numbers in the ASCII format
  x_0 y_0 CR/LF
  x_1 y_1 CR/LF
  x_2 y_2 CR/LF etc.,
  x being the independent and y the dependent value.

  The sequence in the REAL format is x_0 x_1 x_2 .... y_0 y_1 y_2....This pattern applies always which is why it is not indicated with each of the subsequent items.

  Bits 0 to 2 of the third number of the header assume the value 2, i.e., sample and scan are defined as follows:
  ascii_sample = x, y
  scan = $sample_0$ [, $sample_n$]...
  real_scan = x_block, y_block

- Two-dimensional with reference value

  Mono traces (one-channel measurements) may contain a reference value or not; it is therefore put in brackets in the following notation:
  ascii_sample = x, y [, ref]
  This means that the numbers are arranged as follows:
  x_0 y_0 [ref_0] CR/LF
  x_1 y_1 [ref_1] CR/LF
  x_2 y_2 [ref_2] CR/LF etc.

  A dual sample (two measured values for the same x-value) is obtained by:
  ascii_sample = x, y [,ref] , y2 [, ref2]

  Generalized, a sample is defined as follows:
  ascii_sample = x, [, y [, ref] [, y2 [, ref2]]]

  An ASCII scan is obtained by a number of samples:
  ascii_scan = $Sample_0$ [$Sample_n$]...

  A REAL scan consists of a number of blocks:
  real_scan = y_block [, x_block [, ref_block] [, y2_block [, ref2_block]]]
  the x-block being defined as
  x_block .= x_0, x_1, [x_n]...

- Three-dimensional (multiscans)

  Multiscans are obtained by successive series of scans:
  multiscan = $scan_0$, $count_1$, $scan_1$ [,$count_n$, $scan_n$]....
  Notice that the number of data of $scan_0$ has been defined in the header, whereas the subsequent ones are indicated prior to the subsequent traces.
  If a multiscan has been obtained by a z-sweep, a one-dimensional field of z-values is added to the multiscan. Bits 0 to 2 of the third number of the header are set to 3.

- One-dimensional with steady X axis

The above-mentioned applies only for trace data which have been obtained by (internal or external) sweeps. FFT data, waveform data and filter-simulation data are characterized by a steady x-axis, i.e., the x-axis is defined by two values in this case. These values are the start value and difference value and named x_def; the structure is defined as fft_scan under Setup earlier in this section.

Multiscan, reference values and z-sweep are skipped, however, dual trace is possible. The different values of the bits 0 to 3 are selected for plausibility check with loading traces and do not imply different data structures.

Info Structure (info_struct)

This data field contains values which appear in the DISPLAY panel and guarantee that a stored trace which is loaded corresponds exactly to its appearance prior to storage. Therefore, the scaling values, e.g., have to be included in the file. This structure is used with storage of trace A, trace B or dual trace, only.

It is reserved and should not be modified, since error could lead to undefined program states. The reason is that all error possibilities are eliminated with user entry and that this structure is considered to be consistent with use. Besides, it contains data which cannot be described here since they would go beyond the scope of this section. It is advisable, if required, to have a file created by the UPL by means of storing a trace variable/variable trace. All settings can be made in the DISPLAY panel and the structure described is completely inserted.

info_struct := trace_no, trace_group, x_info, y_info, y2_info, strings, norm_y1, norm_y2

trace_no indicates trace A (0), trace B (1) or dual trace (3).

trace_group indicates the type of x-axis, in order not to mix frequency and time axes.

x_info := unit, ref_val, ref_unit, log_flag, upper_val, upper_unit, lower_val, lower_unit
y_info and y2_info are set up like x_info.

strings .= x_string, y_string and y2_string are the user-defined axis labels.

norm_y1 and norm_y2 stand for the normalization factors.

unit consists of code (16 bits) and group (16 bits) and specifies the unit of the axis;

ref_val is the reference value used;

ref_unit is the unit assigned to the reference value (expressed again by means of code and group);

log_flag is 0 with linear scale (not zero with log);

upper_val is the top or right limit of the axis;

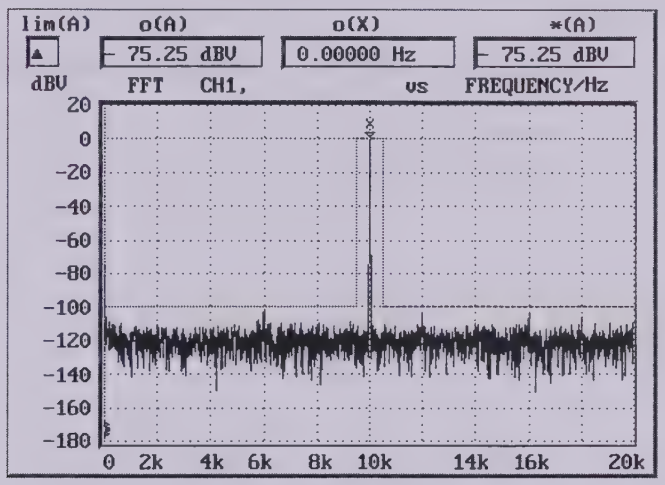
upper_unit indicates code and group of the assigned unit;

lower_val and lower_unit mean the values for the bottom or left limit of scale.

2.9.1.4 Editing Limit Files

Limit files can be edited at the MS-DOS level using any editor capable of generating text files. The sample files R&S_EXAM.LLW (LLW = **L**imit **L**o**W**er) and R&S_EXAM.LUP (LUP = **L**imit **UP**per) used for demonstrating the file structure are stored in the directory C:\UPL\USER.
Each file consists of a header followed by the actual data. Important information can be stored in addition with the aid of comment lines.
The significance of the 7 **header values** can be looked up in section 2.9.1.3 Format of Block/Listen Data/ File header.

Example:
A limit file is to be edited with the aid of which the FFT curve of a DUT can checked for limit violations. The limit value curve should have the following characteristic:



The 7 header values are determined as described in section 2.9.1.3 Format of Block/Listen Data/ File header:

1st number = **213** Number of file format for UPL version 1.0.
The number for UPL versions > 1.0 can be determined by storing a trace file (see 2.9.1.2 Loading and Storing of Series of Measured Values and Block/List Data) and entering `TYPE xxx.TRC | MORE` at the DOS level.
The first number displayed is the number of the file format.

2nd number = **2** The data of this limit file are in the ASCII format, X and Y display next to each other.

3rd number = **10** 10 is the decimal equivalent of 1010:

d15 d0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0

↑ two-dimensional (X and Y values)
↑ always 1

4th number = **1** Number of data sets. 1 for limit files.

5th number = **6** Number of following X-Y pairs. Six values are required for the desired characteristic in the example.

6th number = **0** Linear interpretation of X axis. Irrelevant for the example using only horizontal and vertical lines.

7th number = **0** Linear interpretation of Y axis. Ditto

The interpolation of intermediate values of the limit curves, which are neither horizontal nor vertical, uses these data in the x and y direction. For a correct display of the graphic, the file entries must be in agreement with the actual scaling selected in the DISPLAY

panel, as in the diagram the measured values are always connected by straight lines. If the data do not match, bent curve sections (elliptic segments) are obtained in the calculation which are not displayed and therefore not detected.

Y values entered in the limit file must be multiplication factors which, together with the value specified in the DISPLAY panel under

```
┌──────── DISPLAY ─────────┐
│TRACE A        FUNCT CH1  │
│Limit Ref      VALUE      │
│               1.0000 V   │
```

form the level value used for the limit value check.

Note: *The **use of multiplication factors** in the limit file permits limit curves to be shifted in the display as required by a change of the `Limit Ref` value. Thus the curves can be adapted to a modified generator level or another DUT.*

Thus, the value 0.00001 (1V • 0.00001 = 0.00001V = -100 dBV) is calculated as the multiplication factor for the desired Y value -100 dBV.

X values	Desired Y values in the graphics display	Multiplication factors to be entered in the limit files
20 Hz	-100 dBV	0.00001
9500 Hz	-100 dBV	0.00001
9500 Hz	0 dBV	1.0
10500 Hz	0 dBV	1.0
10500 Hz	-100 dBV	0.00001
20000 Hz	-100 dBV	0.00001

Content of the desired limit file:

```
213
2
10
1
6
0
0
#----X-----Y---
20       0.00001
9500     0.00001
9500     1.0
10500    1.0
10500    0.00001
20000    0.00001
```

This file is stored at the MS-DOS level for instance under C:\UPL\USER\MYLIM.LUP and loaded for a display on the UPL screen as described in section 2.10.7 Limit Check.

```
┌──────── DISPLAY ─────────┐
│LIMIT CHECK ------------  │
│  Lim Upper    FILE       │
│  Filename     MYLIM.LUP  │
```

Note: *Additional information on the use of limit files is given in the Application Note **1GA33_1E** (English) or **1GA33_1L** (American), which can be obtained from local Rohde & Schwarz sales organizations.*

2.9.1.5 Generating a Limit file from a Trace File

Example:
The passband range of a DUT with a C MESSAGE characteristic is to be checked with the aid of an upper and lower limit curve for compliance with a specified tolerance.

The simplest way to generate the two limit files is to create them from a trace file obtained by means of a sweep via a C MESSAGE filter. This ensures that the measured values of the limit curve correspond exactly to the x values of the sweep (provided they are not manually changed) so that the y values need not be interpolated for the detection of limit violations.

In this example the UPL-internal C MESSAGE filter is used.

Creating the trace file:

- Load the default setup:

```
┌──────── FILE ─────────┐
│LOAD INSTRUMENT STATE  │
│Mode          DEF SETUP│
```

- Establish an internal connection to the generator, set the C MESSAGE filter for the RMS measurement and select dBV as display unit.

```
┌──────── ANALYZER ─────┐
│Ch1 Input...GEN CH1    │
│Filter        C MESSAGE│
│Unit Ch1      dBV      │
```

- Set an auto sweep with 10 sweep points (to obtain a manageable number of limit values later on) and an output level of 0 dBV:

```
┌──────── GENERATOR ────┐
│SWEEP CTRL  AUTO SWEEP │
│Points      10         │
│VOLTAGE     0.0000 dBV │
```

- Switch to curve display and select a logarithmic scale for the X axis:

```
┌──────── DISPLAY ──────┐
│OPERATION     CURVE PLOT│
│X AXIS                 │
│Spacing       LOG      │
```

  Switch to graphics windows (□↔□ key or ALT Z)
- The sweep is triggered with the SINGLE key and the curve of the C MESSAGE filter is displayed.
- This curve is now stored as TRACE file under the filename CMESS.TRC:
-

```
┌──────── FILE ─────────┐
│STORE TRACE/LIST ----  │
│Format        ASCII    │
│Filename      CMESS.TRC│
```

  The file is now available under C:\UPL\USER\CMESS.TRC with frequency values in Hz and levels in V.
- Quit the UPL (SYSTEM key or CTRL F9).

Creating limit files from the trace file

Files CMESS.LUP (upper limit curve) and CMESS.LLW (lower limit curve) are generated from the CMESS.TRC file at the DOS level using any editor available by modifying the level values in V derived from the TRACE file so that the desired tolerance mask is obtained.

The Y values to be entered in a limit file are ***multiplication factors*** *which, together with the value entered in the DISPLAY panel under*

```
┌──────── DISPLAY ──────┐
│TRACE A       FUNCT CH1│
│Limit Ref     VALUE    │
│              1.0000 V │
```

form the level value used for the limit check. The curve can be shifted by varying the `Limit Ref`.

Content of C:\UPL\USER\CMESS.TRC:

```
213
2
10
1
10
1
0
#--X---------Y-------
20000       0.000251874
9283.18     0.00154384
4308.87     0.109695
2000        0.879042
928.318     0.978155
430.887     0.317451
200         0.0551856
92.8318     0.00598586
43.0887     0.000624106
20          7.48084e-05
```

The data following in this list are of no importance for the generation of limit files and are therefore left out.

Content of C:\UPL\USER\CMESS.LUP:

```
213  }
2    |
10   |
1    } Unchanged from CMESS.TRC
10   | 1)
1    | 2)
0    } 3)
#--X---------Y---
20000       0.0004
9283.18     0.01
4308.87     0.5
2000        1.2
928.318     1.1
430.887     0.5
200         0.08
92.8318     0.009
43.0887     0.0009
20          0.0004
```

Content of C:\UPL\USER\CMESS.LLW:

```
213  }
2    |
10   |
1    } Unchanged from CMESS.TRC
10   | 1)
1    | 2)
0    } 3)
#--X--------Y----
20000       0.00001
9283.18     0.0008
4308.87     0.03
2000        0.7
928.318     0.9
430.887     0.16
200         0.03
92.8318     0.003
43.0887     0.0001
20          0.00001
```

Multiplication factors used for determining the limit values together with the `Limit Ref` value in the DISPLAY panel.

1) Number of limit values
2) Interpretation of X axis: 0 = linear, 1 = logarithmic
3) Interpretation of Y axis: 0 = linear, 1 = logarithmic
See 2.9.1.3 Format of Block/Listen Data / File header

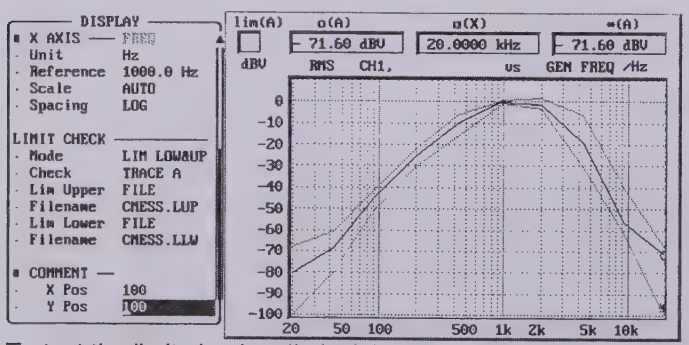
Loading limit files and detecting limit violations:

After starting the UPL again, the two limit files

```
DISPLAY
LIMIT CHECK ---------
Lim Upper     FILE
Filename      CMESS.LUP
Lim Lower     FILE
Filename      CMESS.LLW
```

are entered and the desired tolerance mask is displayed.

If a sweep is triggered now with the SINGLE key, the curve of the C MESSAGE filter is within the tolerance mask as expected, and no limit violation is signaled.



To test the limit check, a limit violation can be produced by increasing the 0-dBV sweep level in the GENERATOR panel to for instance 1 dBV or changing the `Limit Ref` value so that the limit curve is shifted.
In the top left-hand corner of the graphics display the icon

is displayed indicating with an arrow pointing upwards that a limit has been **exceeded**.

To find out the exact reason for the limit violation,

```
┌──────── DISPLAY ────────┐
│OPERATION    SWEEP LIST  │
```

can be set in the DISPLAY panel. A list of all sweep parameters is displayed in which the limit violation is marked at the left by an arrow pointing upwards.
When selecting full-screen display (key □↔□ followed by GRAPH or ALT Z and then ALT R) an extended list of sweep parameters is displayed with measured values of both limit curves.

Note: *If the **x values** from the trace file are read into the limit file **unchanged,** columns 3 and 4 display the product of the multiplication factor in the limit file and of the `Limit Ref` value in the DISPLAY panel. If the **x values have been changed,** the **interpolated** limit values for the frequencies in column 2 are displayed in columns 3 and 4.*

```
   RMS   CH1,                  vs   GEN FREQ
o-> - 70.76 dBV                    20.000 kHz   - 68.0 dBV  -100.0 dBV
    - 55.17 dBV                     9.283 kHz   - 40.0 dBV  - 61.9 dBV
    -18.215 dBV                     4.309 kHz   - 6.02 dBV  -30.46 dBV
    -0.1195 dBV                     2.0000 kHz    1.584 dBV  -3.098 dBV
▲    0.8245 dBV                     928.3  Hz     0.399 dBV  -1.570 dBV
    - 8.955 dBV                     430.9  Hz   - 6.02 dBV  -15.92 dBV
    -24.175 dBV                     200.00 Hz   -21.94 dBV  -30.46 dBV
    - 43.46 dBV                     92.83  Hz   - 40.9 dBV  - 50.5 dBV
    - 70.91 dBV                     43.09  Hz   - 60.9 dBV  - 80.0 dBV
    - 74.79 dBV                     20.000 Hz   - 68.0 dBV  -100.0 dBV
```

Measured level	Sweep frequency	Measured values of upper limit curve acc. to CMESS.LUP	Measured values of lower limit curve acc. to CMESS.LLW

```
┌──────── DISPLAY ────────┐
│OPERATION    SWP LIM REP │
```

shows a list of limit violations. In this example there is only one entry:

```
   RMS   CH1,                  vs   GEN FREQ
▲    0.8245 dBV                     928.3  Hz     0.399 dBV  -1.570 dBV
```

Note: *Further information on the use of limit files can be obtained from the Application Note **1GA33_1E** (English) or **1GA33_1L** (American) which can be obtained from local Rohde & Schwarz sales organizations.*

2.9.1.6 Generating a Limit File using an Application Program

Application Note ***1GA33_1E*** *(English) or* ***1GA33_1L*** *(American)* and the application program **LIMIT.BAS** are available for convenient generation of limit files for use in frequency response measurements. The application program can be obtained from local Rohde & Schwarz sales organizations.

The Universal Sequence Controller UPL-B10 must be installed in order to use the program. With the aid of this option, complete measurement sequences can be run under program control on the audio analyzer.

To be able to run the application program LIMIT.BAS under the Universal Sequence Controller UPL-B10, an Audio Analyzer UPL of version 1.0 or higher is required. An external keyboard must also be connected.

2.9.1.7 Limit Report

The limit report list is organized like the content of a limit file (see **2.9.1.4 Editing Limit Files**) and includes the information 0, 1, 2 or 3 for each frequency value.

0: No limit violation

1: A value or curve defined as `MODE = LIM UPPER` in the DISPLAY panel was **exceeded** by a sweep or FFT curve.
If more than one sweep or FFT curve is displayed, e.g.
- one curve on trace A and one on trace B with `CHECK = TRACE A+B` selected in the DISPLAY panel,
- or several sweep scans are set in the DISPLAY panel,
then one of the curves has exceeded the upper limit.

2: A value or curve defined as `MODE = LIM LOWER` was **below this limit**.
If more than one sweep or FFT curve is displayed, one of the curves is below the lower limit.

3: If the Lim Lower and Lim Upper values or curves are simultaneously displayed in the `Mode = LIM LOW&UP` and more than one sweep curve is displayed, e.g.
- one curve on trace A and one on trace B with `CHECK = TRACE A+B` selected in the DISPLAY panel,
- or several sweep scans are set in the DISPLAY panel,
3 indicates that one of the sweep curves is **below** the lower limit **and** that **at the same time** another sweep curve has **exceeded** the upper limit.
Code **3** cannot be assigned in the case of FFT curves as the limit check for `TRACE A+B` **cannot** be made simultaneously.

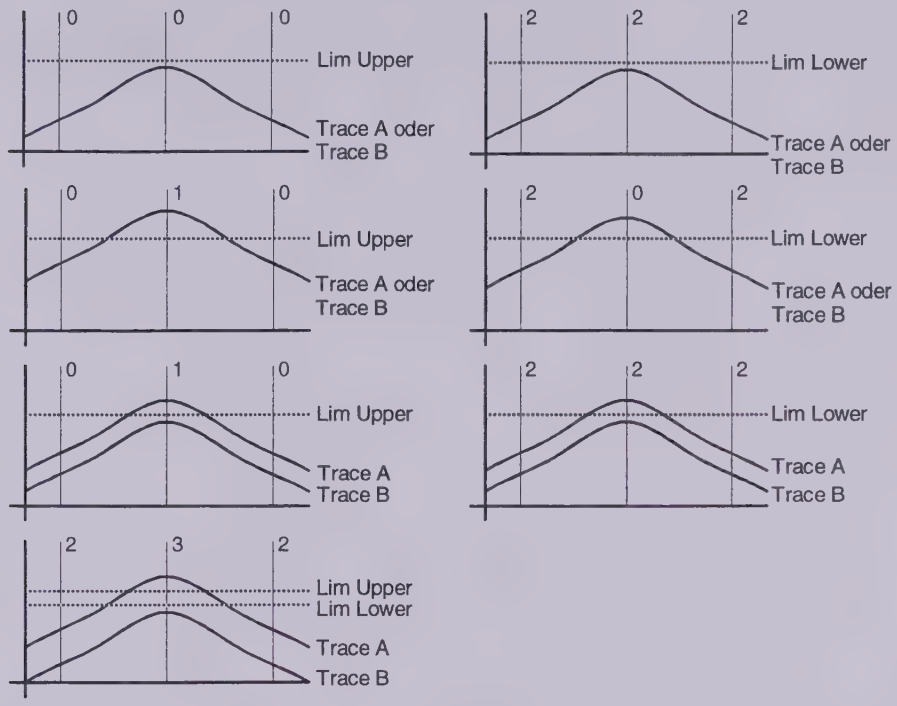


Fig. 2-38 Examples of limit violations and codes

When
`Format = ASCII` has been selected in the FILE panel under

```
┌──────────── FILE ────────────┐
│STORE TRACE/LIST              │
│Store          LIM REPORT     │
│Format         ASCII          │ or REAL,
```

codes 0, 1, 2 or 3 are stored as ASCII values, for
`Format = REAL` these values are stored in binary form (4 bytes each) to IEEE standard.

The X values for which a limit violation has been detected can be seen in a comparison of the traces files and the LIM REPORT file (SCPI does not offer a more convenient solution):

Limit report for sweep curves:

The sweep curve used for a limit check can be selected as follows in the DISPLAY panel:

```
┌──────── DISPLAY ─────────┐
│LIMIT CHECK ------------  │
│CHECK          TRACE A    │ or TRACE B or TRACE A+B
```

Note: `CHECK = TRACE A+B` *with a view to limit violations can only be set for sweep curves (not for FFT curves) if* `Scale B = EQUAL A` *has been selected for* `TRACE B` *(the scale of trace A is also assigned to scale B).*

To view limit violations on the screen, set

```
┌──────── DISPLAY ─────────┐
│ OPERATION SWP LIM REP    │.
```

Only limit violations will be displayed.

To determine the X values for which a limit violation has been detected, the trace file has to be generated for a comparison with the LIM REPORT file:

```
┌──────── FILE ──────────┐
│ STORE TRACE/LIST       │
│ Store      TRACE A     │ or TRACE B
│ Filename   XXX.TRC     │
└────────────────────────┘
```

In contrast to the screen display, where only limit violations are displayed under the setting `OPERATION = SWP LIM REP`, the trace file contains **all** sweep points.

Example:

Content of trace file

```
213 ┐
2   │
10  │
1   ├ see 2.9.1.3 File header
10  │
0   │
0   ┘
#--X---------Y-----
100          0.1138
166.81       0.2326
278.265      0.4104
464.159      0.6457
774.264      0.8959
1291.55      1.0891
2154.44      1.1521
3593.81      1.1058
5994.84      0.9271
10000        0.6069
```

Subsequent data are of no relevance for a check of the LIM REPORT file and are therefore left out.

Content of LIM REPORT file

```
213 ┐
2   │
9   │
1   ├ see 2.9.1.3 File header
10  │
0   │
0   ┘

0 ┐
0 │
0 │
0 │
0 ├ Limit report
1 │
1 │
1 │
1 │
0 ┘
```

Lim report for FFT curves:

The FFT curve used for a limit check can be selected as follows in the DISPLAY panel:

```
┌──────── DISPLAY ──────────┐
│LIMIT CHECK ---------------│
│CHECK        TRACE A       │ or TRACE B
└───────────────────────────┘
```

Note: *Limit violations of FFT curves can only be checked for TRACE A* ***or*** *TRACE B. Selection of TRACE A+B is not possible.*

To view limit violations on the screen, set

```
┌──────── DISPLAY ──────────┐
│ OPERATION SPC LIM REP     │
└───────────────────────────┘
```

Only limit violations are displayed on the screen.

To determine the X values for which a limit violation has been detected, the trace file has to be generated for a comparison with the LIM REPORT file:

```
┌──────── FILE ──────────┐
│ STORE TRACE/LIST       │
│ Store      TRACE A     │ or TRACE B
│ Filename   XXX.TRC     │
└────────────────────────┘
```

Note: *In contrast to a sweep trace,* ***only*** *the limit violations are stored in the trace file for the FFT trace. Therefore, when a suitable upper limit value is selected, the noise floor of the FFT can be suppressed and the quantity of data reduced.*

Example:

Content of trace file

```
213  ⎫
2    ⎪
76   ⎪
1    ⎬ see 2.9.1.3 File header
3    ⎪
0    ⎪
0    ⎭
#--X---------Y-----   →
9984.38     0.5991    →
9996.09     0.9714    →
10007.8     0.8815
```

Subsequent data are of no relevance for a check of the LIM REPORT file and are therefore left out.

Content of LIM REPORT file

```
213⎫
2  ⎪
9  ⎪
1  ⎬ see 2.9.1.3 File header
3  ⎪
0  ⎪
0  ⎭

1 ⎫
1 ⎬ Limit report
1 ⎭
```

2.9.2 Editing Files and Directories

The following files are available under the heading UTILS in the FILE panel, which is called by pressing the FILE key.

The UPL software is supported by the DOS operating system and uses its file manager, which is normally not of importance for the user. It however provides extended capabilities, which you can make use of, if desired. For reasons of internal management, the UPL software assigns a fixed data type (extension) to each file type depending on its function, allowing the identification of the file type. The extension consists of up to three letters after the point in the file name and is usually not available to the user in other menu items (the extension used is specified in the menu items concerning files as well as in the list given in Section 2.9.1).

Delete — A file can be deleted using this command. All menu commands used to store files overwrite an existing file with the same name or create a new file.

Work dir — (Working directory)

If a directory is specified under "Work dir" that exists in the UPL, the specified directory is selected as working directory. If such a directory does not exist in the UPL, the entry is interpreted as a file name indicating a control file in which working directories can be specified for various types of file (with file extensions .SCO, .SAC, etch). If the control file cannot be found either, the user is offered three possibilities in a dialog box.

1. "Create": the entry is interpreted as the name of a new working directory which is opened and activated.
2. "Work Dir unaffected": this entry is stored under Work Dir without the previous work directory being changed. When a setup is loaded holding an entry generated in this way under Work Dir, the current working directory remains unchanged. *This means that by entering a non-existing working directory, setups can be generated which do* ***not*** *change the current working directory when loaded.*
3. "Back to filebox": an entry error has occurred, another working directory can be selected in the filebox.

Specifying a directory:

Files can be arranged in directories allowing classification depending on, for example, the user or the project. The working directory, which precedes all file names and path names (unless they begin with a "\" in the main directory) is thus selected. Independent of the working directory, there are also directories which are used by the UPL-internal software.

Example: Work Dir C:\UPL\DUT04

No.	Data input	Data access to
1	SWEEP.SCO	C:\UPL\DUT04\SWEEP.SCO
2	\SWEEP.SCO	C:\SWEEP.SCO
3	\UPL\DUT05\SWEEP.SCO	C:\UPL\DUT05\SWEEP.SCO

Storing files in the main directory (example 2) or in the UPL system directories (\UPL,\UPL\REF,\UPL\DRIVER, etc.) should be avoided.

Entry of a file with control statements:

The specified file contains control statements by which a working directory is defined for various types of file.

All file names entered into the file box without a path being specified are searched for in, and taken from, the working directory defined in the control file. The working directory shown in the file box under the specified file name can be checked against the file name displayed on the UPL.

(Control file (ASCII text):	Meaning:
#Comment 1	Any comment, marked with #
.SCO C:\EXAMPLE\SETUP	Loading and storing of setups
.SAC C:\EXAMPLE\SETUP	according to \EXAMPLE\SETUP
.TRC C:\EXAMPLE\TRACE	Loading and storing of traces
#Comment 2	
.PPC C:\UPL\USER	Protocol definitions
.PAC C:\UPL\USER	
.PAU C:\UPL\USER	
.* C:\UPL\USER	Preset directory

The control file can be created at the DOS level using any type of editor capable of generating unformatted ASCII text.

.* Designates the working directory that is set if a type of file not included in the control file is entered (default directory).

Marks comment lines.

Leading and filling blanks are ignored. Entries can be made in any order.

If no appropriate entry is found for a specified file type, the directory specified after ".*" is used as working directory. If no entry exists for ".*", the path information (e.g. C:\UPL\USER) is extracted from the file name designating the control file (e.g. C:\UPL\USER\EXTDIR:CFG) and entered as working directory. If in the control file a working directory is specified that does not exist, an error message is output.

Note: *Several users can use setups jointly and store the results separately by using the same path for the setups and different paths for the data to be stored.*

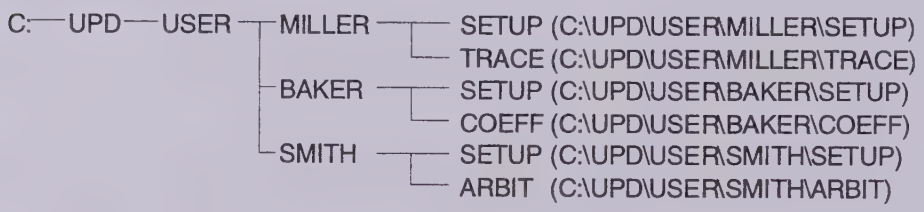
Example:

Mr. MILLER, Mr. BAKER and Mr. SMITH are sharing an UPL. Each user wants a working directory of his own with the corresponding setups using the .SCO and .SAC file types and each one establishes a path named SETUP.

Mr. MILLER	mainly works with .TRC trace files and therefore needs a path named TRACE.
Mr. BAKER	mainly works with .COE filter coefficient files and therefore needs a path named COEFF.
Mr. SMITH	mainly works with .FFT arbitrary waveform files and therefore needs a path named ARBIT.

All files of a type other than mentioned above are to be directly written to/read from the paths C:\UPL\USER\MILLER, C:\UPL\USER\BAKER or C:\UPL\USER\SMITH.

The above requirements can be fulfilled by structuring the working directories as follows (at the DOS operating system level):



The assignment of file types to working directories is made in separate control files which are best stored under C:\UPL\USER:

MILLER .CFG

```
# Working directories, depending on file type
.SCO  C:\UPL\USER\MILLER\SETUP
.SAC  C:\UPL\USER\MILLER\SETUP
.TRC  C:\UPL\USER\MILLER\TRACE
# Default working directory
.*    C:\UPL\USER\MILLER
```

BAKER.CFG

```
# Working directories, depending on file type
 .SCO C:\UPL\USER\BAKER\SETUP
 .SAC C:\UPL\USER\BAKER\SETUP
 .COE C:\UPL\USER\BAKER\COEFF
 # Default working directory
 .*   C:\UPL\USER\BAKER
```

SMITH.CFG

```
# Working directories, depending on file type
.SCO  C:\UPL\USER\SMITH\SETUP
.SAC  C:\UPL\USER\SMITH\SETUP
.TTF  C:\UPL\USER\SMITH\ARBIT
# Default working directory
.*    C:\UPL\USER\SMITH
```

After switching on the UPL, each user enters, under "Work Dir" in the FILE panel, the path and name of his control file, or loads a setup in which the path and name of his control file are already entered.

2.9.3 Series of Measured Values (Sweeps and Scans) and Block/List Data

With sweeps, values measured as a function of a variable input quantity are recorded and can be represented in various ways graphically or as numbers. UPL can simultaneously record two traces (Trace A and Trace B). These are in the following referred to as 1 scan.

The variable input quantity, which is usually entered along the X-axis, is determined by the sweep parameters. There are three sweep modes, of which only one can be active at a time:
generator, analyzer and external/time-controlled sweep.

- In the generator sweep, the frequency or the output voltage can be automatically varied (in steps). For sine burst measurements, the ON time and the length of intervals (see 2.5.4.2 Sweeps) can be varied in addition.
- In analyzer sweeps, the "receive" frequency can be automatically stepped in (frequency-) selective rms measurements, with sweep parameter settings similar to those used in generator sweeps (see 2.6.5.3 RMS SELECT). If the multisine function (with up to 17 simultaneous frequencies) is active in the generator, a sweep list can be generated with UPL set to SWEEP CTRL GEN MLTSIN. With this list, the analyzer is automatically tuned to all generator frequencies in consecutive order.
- The third group of sweeps are external sweeps that are likewise set in the analyzer mode. With external sweeps, time-varying signals are analyzed that are not stepped by one of the UPL sweep systems but by external control. The analyzer picks up measurement values after a frequency or level change and interprets the frequency or level as X-axis parameters. Furthermore, measured values can be collected at certain intervals. In this case, time will be taken as the X-axis parameter.

In the DISPLAY panel, the set sweep parameters are always used for the X-axis. The units used depend on the physical quantity measured. The right-hand and the left-hand limit are determined by the start and the stop values of the sweep parameters and set using the X-axis autoscaling function.

2.9.3.1 Scan count =1

From the six values simultaneously measured, two can be used for the two independent Y-axes (trace A and trace B). These values may be the distortion factors of the left-hand and right-hand channel, for example, but also different physical quantities such as voltage and phase. The quantities to be measured are set in the ANALYZER panel; the values to be recorded as a trace are selected in the DISPLAY panel even if a trace is not to be displayed but stored in a file.

Measured values frequently have to be referenced to other values (the measured values being expressed in relative units). If a reference value is constant (e.g. 1 mW), it can be taken into account immediately. If the reference value is a function of the X-axis, a reference trace will result. With UPL, such traces can also be formed from a series of measured values, for example, or from the generator voltage or frequency, or may be loaded from a file (e.g. as reference traces).

In all, the following is stored for one scan: two traces, two reference traces and the X-axis data since, in the case of external sweeps, the latter are also obtained through measurements values and cannot be calculated.

2.9.3.2 Interpolation to a Common X Axis

To allow any traces to be used as reference traces or to be displayed simultaneously for the purpose of comparison, and measured by means of the movable cursors, all traces would have to have the same X values. However, any X divisions can be used on the UPL as the values of the traces and reference traces are interpolated to the set X-axis. The interpolated values are displayed as traces or numerals. The original X and Y values are displayed only if no sweep is selected (and thus no X-axis is set). (Excepted are all limit traces; they are displayed using the original and not the interpolated values (see 2.10.7 Limit Check).

For interpolation, the X and Y values of the four traces and reference traces are stored in the UPL, yielding a total of eight series of numbers plus the four interpolated series plus the current X-axis values. This results in 13 series of 1024 values each.

UPL also interpolates further series of numbers: the limit traces for the upper and lower ranges, the equalization trace for the generator voltage, and the dwell trace for sweep stepping. Thus, only a few measured values are required for each trace. In interpolation, linear or logarithmic scaling of the X and Y axes is taken into account as, when switching from linear to logarithmic scaling, segments of an ellipse would be displayed instead of a straight line.

All traces are interpolated once at the start of a sweep to make for enhanced measurement speed. In the case of external sweeps, the X values are unknown at the start of the sweep. In this case, interpolation cannot be made prior to the sweep but must be performed during the sweep.

2.9.3.3 Scan Count >1

The number of sweeps performed by UPL is not limited to one X sweep but can be increased to n sweeps by means of the setting Scan count <n> (in the DISPLAY panel). A group of traces will be obtained as graphical representation. All traces are stored (in the UPL and also as a file, if desired) and can be displayed as one unit, rescaled and recalled. In the Scan GROUP mode, the 13 series of numbers mentioned above are multiplied by the number of scans.

In the generator mode, a second sweep can be made in addition to the X sweep. The second sweep is referred to as Z sweep as it is usually represented along the Z axis. When Z sweep is selected, the number n of the scans is automatically set to the number of the Z points (Scan count is set according to the number of Z points).

In the Scan count >1 mode, a series of traces (or a series of pairs of traces) is usually displayed. In autoscaling of the Y axes, all available traces are included. Any other operations, e.g. setting the cursor to the min. or max. values, only apply to the current scan. For out-of-tolerance checks (limit checks), all traces are checked against the same two limit traces, the out-of-tolerance symbol applies to the current pair of traces.

The current scan (with one or two traces) is selected with the PAGE UP/PAGE DOWN keys on the keyboard. The current value, i.e. the scan index, is indicated by a number between the out-of-tolerance field and the left-hand cursor-value field. The scan index is set by remote control with command
DISPlay:TRACe:INDex <n>.

The point of intersection of the cursor with the current trace (or pair of traces) is visually emphasized by means of a circle. It is thus possible to allocate the cursor values indicated in the windows unambiguously to the current scan.
The most recently recorded scan is displayed with a number ("#n") in the upper left corner providing the space is not occupied by the out-of-tolerance field.

If one of the list modes (SWEEP LIST, SPECTR LIST, SWeeP LIMit REPort or SPeCtrum LIMit REPort) is selected, the corresponding lists are generated anew after a change of the scan index (with the PAGE UP/ PAGE DOWN keys), since only one scan (pair of traces with X axis) can be displayed at a time.

With FFT, a large amount of numbers (up to 7424) is obtained, although no more than one scan is available. For this reason, the scan index is used for organizing the number in 1-k blocks and selecting them accordingly. This is not only useful for the screen display but also for reading the block data via remote control or the universal scan control with BASIC (UPL-K1). With remote-control command DISPlay:TRACe:INDex, a 1-k block is selected to which the subsequent inputs and outputs with FFTs refer. With sweeps, the command serves for selecting a desired scan from a group (or to select the Z index). The index runs from 0 to Scan count -1.

Another way of reducing the numbers transferred with FFTs is by using the out-of-tolerance function. Only values above the limit value defined by UPPER LIMIT are accepted as measurement values and can be read with LIST1 and TRAC1 or TRAC2 if OPERATION SPC LIM REP is set in the DISPLAY panel. In this case, the error report block which is read in with "CALC:LIM:REP?" is meaningless, since all values would have to be marked as being out-of-tolerance (i.e. by 1) (see 3.10.10 Commands for Input/Output of Block Data).

In the case of sweeps, "0" is entered in the trace index in the error report block if no sweep values are out of tolerance. If the limit in channel 1 is exceeded, 1 is entered, with channel 2, 2 is entered; if limit violations occur in both channels, 3 is entered. The X and Y values belonging to this index will be found under the same index in the LIST1 and TRAC1 or TRAC2 blocks.

If no group of traces is selected (Scan count =1), the measurement currently being taken is indicated by means of a gap moving along the trace. If several traces are displayed on the screen (Scan count >1), the gap may no longer be visible; instead, the set sweep value is marked by an arrow on the X axis.

With time-controlled measurements, which are selected by means of START COND TIME TICK or TIME CHART in the ANALYZER panel, the time is entered along the X axis. With these measurements, the X axis can be extended using the scan group mode. The stop value results, for example, from time = 1 s and points = 100 to yield 100 s. With scan count = 5, the monitoring period is extended to 500 s. The cursor value always indicates the total time; with scan index = 5, 400 to 500 s would be obtained in this case. As for the traces, however, the X-axis values would be in the range 0 to 99 in this

example.

2.10 Graphical Data Presentation (DISPLAY and GRAPHICS Panels)

The DISPLAY panel is used to set how the measurement results are graphically **presented**. Important: **what (and how)** is measured is set in the ANALYZER panel, or, with sweeps, in the GENERATOR panel. How the measurement is displayed can be changed at a later date, too. Also, curves can be retrieved from files and redrawn.

The DISPLAY panel is built up using the front-panel key DISPLAY or key combination Alt-D on the external keyboard. The menu items in the DISPLAY panel affect the GRAPHICS panel which occupies either 2/3 of the screen (part-screen graphics mode) or the complete screen (full-screen graphics) (selectable by the ◻◀▶◻ key or key combination ALT-Z).

OPERATION	
CURVE PLOT	The results of a sweep, function of time (waveform) or FFT are entered as line diagram in the Cartesian coordinate system. As a rule, two dependent variables (TRACE A and TRACE B) can be displayed above an independent variable (X AXIS). With LIMIT check activated, the tolerance masks are also included. The extensive command menu provided on the softkeys allows you to scale and zoom the display and to dimension the display using the Cursors (see 2.10.1 and 2.10.2 Trace and Spectrum Display).
SWEEP LIST **SPECTR LIST**	The measurement results of a sweep or (post) FFT are output in the form of digits. The three columns (TRACE A, TRACE B and X AXIS) are complemented by a fourth column where violations of the UPPER or LOWER LIMIT curve are marked. In full-screen graphics mode, two additional columns indicate the LIMITS (interpolated between intermediate values!) (see 2.10.3 and 2.10.4) if LIMIT CHECK has been activated (see 2.10.7).
SWP LIM REP **SPC LIM REP**	As opposed to TRACE LIST, the digit lines with measured values exceeding the tolerances only are displayed (see 2.10.3 and 2.10.4), which is possible only with LIMIT CHECK activated (see 2.10.7).
BARGRAPH	The current measured values are displayed in analog form as bars ('signal level meter'). This type of indication is ideally suited for measurements where the relative size or change in size - and not the exact value - is desired. Max. 3 BARGRAPHS are displayed. The extreme values are marked by trailing pointers (see 2.10.5 and 2.10.6). The bargraphs #1 and #2 are freely selectable, the bargraph #3 is automatically assigned the following functions (in the order of their priority): 1. with activated sweep: swept parameter 2. (x-axis or sweep curve) 3. with activated phase measurement: phase 4. with activated frequency measurement: frequency channel 1 or 2 5. Generator frequency (if selected generator function permits frequency to be entered)

OPERATION

SPECTRUM

With FUNCTION FFT or POST FFT selected in the ANALYZER panel, the frequency spectrum calculated by the DSP is displayed (SPECTRUM is automatically set with FFT or FILTER SIM selected in the ANALYZER panel).

With FUNCTION MOD DIST, DFD or THD selected in the ANALYZER panel, the spectrum components of the stimulae and interference products can be displayed in the form of a histogram (see 2.10.1 and 2.10.2).

PROTOCOL

In the GRAPH window, the protocol data of the digital interface are displayed. Evaluation of the protocol is made simultaneously with the respective function (see 2.10.8).

Mode

(With FFT spectrum only)

DEL BEF WR

This is to select a trace, or pair of traces (trace A and trace B). Each new trace will overwrite the previous trace(s).

MAX HOLD

This key is used to switch on the MAXimum HOLD function. FFT AVERAGE cannot be set unequal to 1 in the ANALYZER panel with OVERL/MAX H selected, see 2.6.5.12.

Note: *MAX Hold can only be selected if the display is switched off (Avg count 1).*

WATERFALL

Shifts the single curves in the z-axis to obtain a spatial impression. One channel only can be traced at a time, which is why 1 or 2 must be selected under "Channel(s)" in the ANALYZER panel. To obtain a useful display, scaling is to be set as follows:

1. TRACE Top is to be set such that the upper half (or 3/5) of the coordinate system is empty (i.e. is not occupied by the first trace).
2. X-AXIS Right such that about half of the coordinate system is free.
3. TRACE Bottom is to be set above the noise limit, making noise invisible by clipping and emphasizing significant spectral components.

Note: *Waterfall can only be selected with one-channel analyzer.*

Scan count

(With CURVEPLOT, SWEEP LIST, SWP LIM REP and BARGRAPH operation only, not with spectrum displays)

Defines the number of single traces or trace pairs to be measured and displayed. If a Z sweep is selected in the generator, the number of Z values is automatically entered in Scan Count.

1

A single trace or a trace pair (Trace A and B) should be measured or loaded. Each new curve overwrites the previous one. With this setting a continuous sweep (without Z axis) is performed repeatedly but only the last one is stored.
If a single-scan trace is loaded from the file, the file overwrites the current contents of the trace buffer.
If a multiscan trace is loaded from the file, only the 1st scan is loaded into the trace buffer, all others are ignored.

>1

With this setting, not only one measurement sequence (sweep run, scan) is measured and displayed but as many as required. However, only the selected number, but not more than 17, are internally stored in or read from a file. Non-stored scans are only displayed in the curve plot and lost during rescaling, storing/loading of trace files or upon storing/loading of ACTUAL+DATA setups.
A continuous sweep (without Z axis) is terminated after the specified number of sweeps but only the last 17 sweeps are stored.
If a single-scan trace is loaded from a file, this scan is *appended* to the existing scans.
If a multiscan trace is loaded from the file, the trace buffer is *cleared* and the number of scans specified here is loaded into the trace buffer, all other scans of the file are ignored.
If more than the specified number of scans are performed, only the last (max. 17) scans are stored.
If more than 17 scans are specified, only the last 17 are stored.

For more details refer to section (see 2.9.3.3 Scan Count >1)

Note: *Scan Count can be* ***increased*** *any time for storing more scans in the trace buffer.* ***Reducing*** *the Scan Count clears the trace buffer and provides an empty display again.*

User Label

OFF

The units and function labeling in the graphical display are automatical generated by UPL.

ON

The user can assign his own units and function labels. This is of interest in particular for remote control if measured values were converted. The labeling is entered in UNIT/Label under Trace A/B or X axis. When User Label is switched from OFF to ON, the labeling assigned by UPL appears in the input fields and can be overwritten by the user.

2.10.1 Parameters for Display of Traces and Spectra (DISPLAY Panel)

TRACE A

TRACE B

Is used to select which measurement results are to be collected and graphically represented as TRACE A (or TRACE B) e.g. in the case of a sweep.

Note: *Display of the trace can be switched OFF (invisible) by means of a softkey.*

OFF

No measured values are collected and hence, nothing can be displayed under this TRACE.

FUNC CH1

(Function Channel 1)
The results of the measurement of channel 1 currently selected in the ANALYZER panel by way of FUNCTION are used. Possible only when FUNCTION in the ANALYZER panel is not OFF.

FUNC CH2

As above, however for channel 2.
(Frequency Channel 2)

FREQ CH1

Frequency meter channel 1. Possible only with FREQ/PHASE in the ANALYZER panel not OFF and OPERATION not SPECTRUM.

FREQ CH2

Frequency meter channel 2. Possible only with FREQ/PHASE in the ANALYZER panel set to FREQ and OPERATION not SPECTRUM.

PHASE

Phase meter between channel 1 and 2. Possible only with FREQ/PHASE in the ANALYZER panel set to FREQ&PHASE and OPERATION not SPECTRUM.

INP RMS CH1

RMS measurement results channel 1. Only possible if measuring function THD or THD + N/SINAD and channel 1 are set.

INP RMS CH2

RMS measurement results channel 2. Only possible if measuring function THD or THD + N/SINAD and channel 2 are set.

HOLD

Does not collect new values but continues to display the old trace.
HOLD is only accepted as input if valid trace data or FFT data are provided.

A sweep stored in a file in the FILE panel (TRACE LIST) can be recalled and displayed, e.g. for comparison purposes, using this option.
Sweep lists can be stored as a group of traces (Scan count >1 in the DISPLAY panel) in a file. To recall this group of traces, Scan count must also be set to this number, otherwise an error message is output. (See 2.9.1.2 Loading and Storing of Series of Measured Values and Block/List Data, and 2.9.3.3 Scan Count >1).
If a pair of traces is stored in a file (with Store TRACE A + B in the FILE panel) and if this pair is loaded by means of FILE, only trace A is used and trace B is ignored. To load the pair of traces, the parameter DUAL FILE should be used.

TRACE A/B *(continued)*

FILE

Sweep lists and FFT files can be loaded.

The following basic conditions must be satisfied to load a sweep list.
- ➢ The display OPERATION must be set to CURVE PLOT, SWEEP LIST or SWP LIM REP.
- ➢ All sweeps must be switched to OFF (or START COND to AUTO) or the sweep parameter (FREQ, VOLT, TIME) must be identical to the X-axis of the trace file to be loaded.

The following condition must be satisfied to load an FFT or FILTER SIM file.
- ➢ The display OPERATION must be set to SPECTRUM, SPECTR LIST or SPC LIM REP.

For loading a waveform file
- ➢ the WAVEFORM function must be set in the ANALYZER panel (this causes CURVEPLOT to be set automatically in the display).

When loading the trace file, TRACE A has the function of a "master" trace; trace B is the "slave" trace:

- ➢ The "master" trace can always be loaded as soon as the above basic conditions are satisfied. In addition to the trace data, the stored display settings including the complete X-axis are also loaded (cf. Section 2.9.1.2, menu item STORE → TRACE A/B). If a sweep has been selected, the loaded trace is interpolated on the X list specified by the sweep.
- ➢ When trace A is switched off, TRACE B becomes the "master" trace.
- ➢ Being the "slave" trace, TRACE B must conform to the X-scale of the "master" trace; i.e., only the trace data and the appropriate Y-scale are loaded. The curve is interpolated on the X-axis already specified. If this X-axis is incompatible, the "slave" trace is switched off.

DUAL FILE

In the FILE panel, a pair of traces can be stored as a unit in a file by means of TRACE A + B under STORE. The pair of traces can be recalled by means of DUAL FILE (under TRACE A). The parameter of trace B, too, is set to dual trace and the scaling of both traces as well as any reference values or reference traces are loaded from the file.

GROUP DELAY

GROUP DELAY can be switched on only, if FREQ/PHASE has been set to FRQ&GRPDEL in the ANALYZER panel (this is possible with two-channel measurement, only). The group delay calculated from the phase measurement is displayed).

Filename

(Displayed with TRACE A/B FILE only)

The name of the file with a sweep or FFT to be displayed is entered. If an error occurs during loading, "NOT FOUND" is output in this line.

Scale B

EQUAL A

The second (dependent) measured value is displayed using the same scaling as for Trace A. Any values for UNIT, REFERENCE, SCALE, SPACING, TOP and BOTTOM need not be entered for the second axis. This requires however that the same function is selected for TRACE A and B (only the channel may be different).

NOT EQUAL A

Different scaling for the second sweep.

Unit

Is used to specify the unit with which the results are to be displayed (see 2.4 Units). Recorded sweeps can be redisplayed with other units at any time. Traces loaded using TRACE A/B FILE therefore need not be drawn in the same way as they have been stored.

Unit/Label

Entry of a string which specifies a freely definable unit and axis label. The string consists of 5 characters for the unit which are centered and if need be padded with blanks, and 12 characters for the axis label which are also centered and if need be padded with blanks. There is a separate "Unit/Label" command for each trace and the x-axis.

Reference

Displayed only if a relative unit is selected in the menu item "Unit".

Selection of reference. This may be a single numeric value or a data record (reference trace). It applies to all numeric values of the trace, i.e. top, bottom, measured and limit values.

MAX

The maximum value of the sweep is adopted once as reference value.

*** CURSOR**
o CURSOR

The value on which the cursor is placed is adopted once
(not with BARGRAPH)

VALUE:

A numeral with unit is entered.

Reference

FILE

The reference trace is loaded from the file. The file name is entered in the following line.
If a pair of traces is stored in a file, trace A is loaded. If a reference trace is assigned to trace A, the reference is ignored. If Scans GROUP is selected, a group of traces is loaded. If the number of traces stored does not coincide with the Scan count number, an error message is output.

OTHER TRACE

The reference trace is loaded with the trace data of the other trace. Every new measured value of the other trace is simultaneously entered in this reference trace and is then immediately available for representation of the new test point. If the other trace is OFF or inactive (e.g. because an invalid file name has been entered), a corresponding warning is output. If the other trace is incompatible (e.g. TRACE A FREQ CH1 and TRACE B → INP RMS CH1), a corresponding warning is output. If the other trace is set to FILE or HOLD, the compatibility is not checked.

MEAS CH1

The reference trace is cleared and then loaded with the measured values of channel 1. These are

- function measurement results of channel 1 if trace "FUNC CH1" or "FUNC CH2" is selected
- frequency measurement results of channel 1 if trace "FREQ CH1" or "FREQ CH2" is selected
- input rms measurement results of channel 1 if trace "INP RMS CH1" or "INP RMS CH2" is selected

This choice is only offered if both channels are activated and TRACE (with activated phase measurement) is not set to FREQ CH1 or PHASE.

MEAS CH2

The reference trace is cleared and then loaded with the measured values of channel 2 (as above, applying for channel 2).

GEN TRACK

The reference trace is cleared and loaded with the currently valid g setting in every measurement. This is

- the generator rms value valid at the respective test point if trace "FUNC CH1" or "FUNC CH2" is selected,
- the generator frequency valid at the respective test point if trace "FREQ CH1" or "FREQ CH2" is selected,
- the generator rms value valid at the respective test point if trace "INP RMS CH1" or "INP RMS CH2" is selected.

HOLD

The reference trace is not changed any more. If HOLD is selected without valid reference trace data being provided, a warning is output and the last valid reference is set again.

FILE INTERN

This option can be selected only if a reference trace was stored in the file. FILE INTERN is set automatically if a trace loaded from a file has a reference trace assigned to it.

Limit Ref

Selection of reference for calculating limit curves if the selected unit is **not** a relative unit.

Note: *Limit files consist of dimensionless numerals and become a physical unit only by a multiplication with the reference value. For this reason a reference value is also required for non-referenced values in the display.*

MAX

The maximum value of the measurements is taken as a reference value.

∗ CURSOR
o CURSOR

The value marked by the ∗- or o-cursor is used as a reference (not in the case of BARGRAPH).

VALUE:

A numeral with unit is entered.

Normalize

Normalizes the displayed trace, if a related (e.g., dBr or V/Vr) and a floating reference value - like OTHER TRACE, MEAS CH1, MEAS CH2 or GEN TRACK- are used. A defined value can be specified to be 0 dBr or V/Vr = 1 by shifting the complete trace (multiplying it with the normalization value).

VALUE

The normalization factor is entered as a numeric value.

o CURSOR

The required normalization value is calculated by means of normalizing the y-value of the current o-cursor position. This is usually the value with 1 kHz, which implies that the cursor has been set to 1 kHz before. By acknowledging this selection, the value is entered under VALUE.

∗ CURSOR

As above, however, the ∗ cursor is used.

Scale

AUTO ONCE

Uses the minimum and maximum values of the current sweep for scaling of TRACE A and B (once) and rescales after changing the function using FUNCTION in the ANALYZER panel or TRACE A/B in the DISPLAY panel. The sweep or FFT start/stop values of the GENERATOR or ANALYZER panel are adopted for the X-axis. The following menu items TOP and BOTTOM or LEFT and RIGHT are no longer displayed because they have been set in doing so.
If there are not yet any measured values available, preset range limits are used for the time being and rescaled after the end of the sweep. When changing the measurement function (using TRACE A/B or FUNCTION in the ANALYZER panel with FUNC CH1/2 or GRAPH ON/OFF with SMPTE, THD and DFD) an automatic rescaling is performed after the first measurement in the SCALE AUTO ONCE state. (Re-) START does not initiate a new scaling.
If Scan count >1 is selected, AUTO ONCE is executed only when all scans have ended (e.g. z-sweep).
The full-scale values of the new scaling are determined about 5 % lower or higher than the exact values. Using an intelligent algorithm, 'even' values appropriate for the scale are selected.

MANUAL

Leaves the scaling to the user.

With a new scaling the image is deleted and redrawn after the rescaling. This applies also to an FFT started by the Single key. With FFT in Continuous mode (started by Start key), however, the running FFT is still drawn, the new scaling being considered only in the next FFT.

Note: *If scale AUTO ONCE is selected, autoscaling is performed when switching between LIN and LOG.*

Spacing

LIN

Divides the Y-axis linearly.

LOG

Divides the Y-axis logarithmically. With logarithmic units (dB) selected, LIN only can be selected.

Notes: *If Scale→AUTO ONCE is selected, autoscaling is performed when switching between LIN→LOG.*

Top

The menu item is displayed only with TRACE A/B SCALE MANUAL. The item serves to set the upper value of the Y-axis (of the scale for the measured values). Negative or 0 values are not permissible with SPACING LOG and logarithmic (dB-) units.

Bottom

(With TRACE A/B SCALE MANUAL), the menu item serves to set the lower value of the y-axis (of the scale for the measured values). The value must be smaller than that of TOP. Negative or 0-values are not permissible with SPACING LOG and logarithmic (dB) units.

Notes on scaling the Y axis:

- A newly selected display unit is assigned to all values from top to bottom but other units may be subsequently selected. Thus it is possible, for instance, to select a logarithmic scale (e.g. dBr) as a unit and to enter absolute units for the top and bottom values (e.g. in Volt).
- *Exception:* If a reference trace is active, entering an absolute unit for the top and bottom values is physically meaningless. For this reason no unit is offered in this case, the numeric values are assigned the unit selected under "Unit".
- If a referenced unit is set for the top or bottom value, the trace is vertically shifted when the reference value is changed.

Left

(With X AXIS SCALE MANUAL), the menu item sets the left value of the X-axis (of the independent value). Negative or 0 values are not permissible with SPACING LOG and logarithmic (dB) units.

Right

(With X AXIS SCALE MANUAL), the menu item sets the right value of the X-axis (of the independent value). The value must be selected higher than that for LEFT. Negative or 0-values are not permissible with SPACING LOG and logarithmic (dB) units.

COMMENT

Allows the entry of a comment with a length of max. 27 characters, which is output together with the curve in the case of OPERATION CURVE PLOT.

X Pos

(X Position)
Defines the X-position of the comment. X is the relative distance to the 0-point (bottom, left) in % (0 to 100) of the coordinate system.

Y Pos

(Y Position)
Defines the Y-position of the comment. Y is the relative distance to the 0-point in % (0 to 100) of the coordinate system. 0-point is on the left side at the bottom. The reference point for the text is the first letter (bottom, left).

2.10.2 Trace and Spectrum Display (GRAPH panel)

Basically, two dependent values (TRACE A and TRACE B) can be displayed above an independent value (X AXIS), the scales for TRACE A and TRACE B being displayed on the left-hand and right-hand margin, respectively (unless the same scaling has been selected by way of TRACE B, SCALE B: EQUAL A). The measurement functions selected for display are faded in on the upper margin in the form of letters.

Overrange values are not displayed (the curve is interrupted). Underrange values are indicated in the status line SWEEP INFO in the top, right corner. Measured values not fitting into the selected coordinate system are displayed as horizontal line at the top or bottom.

With THD, MOD DIST and DFD measurements, the measured values can be displayed in the form of a histogram above the frequency axis (with OPERATION SPECTRUM), the frequency axis being not true to scale and invariable.

To allow any traces to be used as reference traces or to be displayed simultaneously for the purpose of comparison, and measured by means of the movable cursors, all traces would have to have the same X-values. However, any X divisions can be used on the UPL as the values of the traces and reference traces are interpolated to the set X-axis. The interpolated values are displayed as traces or numerals. The original X and Y values are displayed only if no sweep is selected (and thus no X-axis is set). (Excepted are all limit traces; they are displayed using the original and not the interpolated values (see 2.10.7 Limit Check).)

There are two cursors marked by * and o, respectively. They can be moved across the display using the rotary knob or the direction keys. The measured values below the cursor positions are displayed in three windows (depending on the function set, also difference values). The cursor jumps from measured value to measured value. If there are more measured values than can be displayed as points (e.g. with FFT), the maximum out of the measured values displayed on one point is displayed. Here, the cursor jumps from line to line.

Also, the cursor can be moved outside the coordinate system and indicate the appertaining values. In this case, its symbol is placed in the top corners.

If no group of traces is selected (Scan count =1), the measurement currently being taken is indicated by means of a gap moving along the trace. If several traces are displayed on the screen (Scan count >1), the gap may no longer be visible; instead, the set sweep value is marked by an arrow on the X-axis.

The current scan (with one or two traces) is selected with the PAGE UP/PAGE DOWN keys on the keyboard. The current value, i.e. the scan index, is indicated by a number between the out-of-tolerance field and the left-hand cursor-value field. The point of intersection of the cursor with the current trace (or pair of traces) is visually emphasized by means of a circle. It is thus possible to allocate the cursor values indicated in the windows unambiguously to the current scan.

With LIMIT check switched on (see 2.10.7 Limit Check), the tolerance masks are displayed, too.

An extensive command menu on the softkeys allows you to scale, zoom the display, select the cursor functions and to set markers on the single frequency lines or the harmonics of the FFT.

The cursor can be moved and the softkeys can be operated only after the GRAPHICS panel has been selected using the front-panel key GRAPH or the key combination ALT-R.

The softkey menus have max. 3 levels. The extremely left key (labeled with "BACK") always returns to the preceding menu level. Its designation is indicated above the BACK softkey and constitutes together with the text displayed in center above the remaining 7 softkeys the heading of the current menu.

Some softkeys indicate ON or OFF states, where ◯ is the symbol for OFF and ◉ for ON.

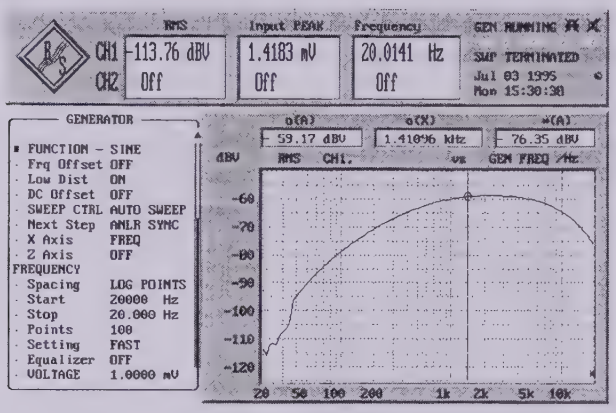


Fig. 2-39

The first two levels of the softkey menu tree are dealt with below. A third level, if any, is explained subsequently.

CURVE

A ◉

B ○

switches the display of curves or lines on or off (toggle key). Display only is affected. (With TRACE A/B in the DISPLAY panel OFF, nothing can be displayed. Changing a function (using TRACE A/B in the DISPLAY panel) switches A and B to ON.)

AUTOSCAL

Rescales the X- and Y-axes using the present measured values of a sweep or the FFT. If there are no measured values, the preset range limits are used and scaled after the end of the sweep. The present display including the axes are deleted and subsequently redrawn (see also AUTOSCALE).

ALL

A

The left-hand trace-A axis only is rescaled, the trace A curve is redrawn.

B

The right-hand trace-B axis only is rescaled, the trace B curve is redrawn. Is ignored with SCALE B set to EQUAL A.

X

The X-axis only is rescaled (not with SPECTRUM and Analyzer FUNCTION THD, MOD DIST or DFD).

0 ○ * ◉

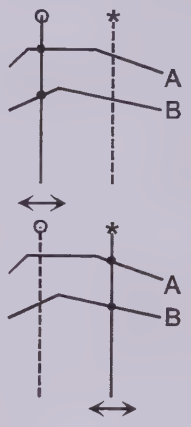
Switches alternately the *-cursor or the o-cursor active. Only the active cursor can be moved using the rotary knob or the direction keys and can display the measured values. The softkeys pressed subsequently (HLINE, SET TO and ON/OFF) refer to the active cursor. The inactive cursor is displayed in short dashes.
The o-cursor is used for the ZOOM function and as reference for the *-cursor and horizontal cursor. The *-cursor can be switched over to horizontal line (not with SPECTRUM).

* CURSOR

The subsequent softkeys serve to select the various cursor functions. The units of the numerical values are determined by the axis scaling.

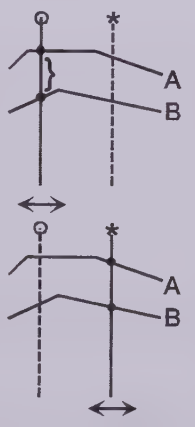
A , B

Display of the measured values of curves A and B at the cursor position as well as the appertaining X-value.

Graphics	Labeling of display field	Selected softkey
	oA oB oX *A *B *X	oCURSOR A,B *CURSOR A,B

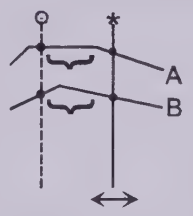
A - B

Display of the difference value between curves A and B at the position of the cursor and of the X-value (useful only with identical physical variables).

Graphics	Labeling of display field	Selected softkey
	 oA-oB (unit of A !) oX *A-*B (unit of B !) *X	oCURSOR A-B *CURSOR A-B

*** - 0**

(With active *-cursor only). Display of the difference between the values at the positions of the *- and o-cursor on curve A (or curve B) and the difference between the X-values.

Graphics	Labeling of display field	Selected softkey
	*A-oA *B-oB *X-oX	*-o

HLINE →

(With active *-cursor and Operation Curve Plot only). Switchover of *-cursor to horizontal cursor. The subsequent command level is described further below.

SET TO →

Sets the active cursor to specific values. The subsequent softkey command level is described further below.

ON/OFF

Switches alternately the cursor on and off. A deactivated cursor is no longer displayed.

ZOOM

Zooms the display in X-direction. The ZOOM function is not active with histogram indication (OPERATION SPECTRUM and simultaneously Analyzer FUNCTION THD, MODDIST or DFD).

AT o UP

Zooms the display on the X-axis by the factor 2 (repeated activation is possible). The center used is the o-cursor which is then also placed in the center. Changes the LEFT and RIGHT parameters of the X-axis in the DISPLAY panel.

AT o DOWN

Compresses the display on the X-axis to half the size (can be activated repeatedly). The o-cursor is the center, which afterwards is in the middle. Changes the LEFT and RIGHT parameters of the X-axis in the DISPLAY panel.

CEN TO o

Sets the center of the X-axis of the new coordinate system to the value of the o-cursor without zooming. Changes the LEFT and RIGHT parameters of the X-axis in the DISPLAY panel.

o TO *

The end values of the new (zoomed) X-axis are predefined by the X-values of the two cursors which will subsequently be placed on these cursor values. Changes the LEFT and RIGHT parameters of the X-axis in the DISPLAY panel. In order to obtain a scrolling effect, the cursors can be shifted to X-values outside the displayed range; the values continue to be displayed.

UNZOOM

Restores the original X-axis, defined by X AXIS LEFT and RIGHT. UNZOOM is also performed internally when modifying and setting a parameter which changes the X-axis. Restores the original LEFT and RIGHT parameters of the X-axis in the DISPLAY panel.

UNDO

Cancels the last ZOOM action (one-time).

MARKER

TRACEA →

TRACEB →

(With FFT only). Switches the display of markers in the form of triangulars above the marked measured value on trace A (or B) ON. The functions are on the next softkey level and described below.

MORE

The **functions of the third (and last) level** of the softkey menu is referred to in the following:

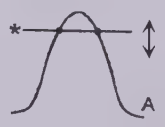
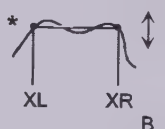
* CURSOR

HLINE

A

B

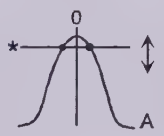
(With Operation Curve Plot (not with FFT) only)
The *-cursor is switched over to horizontal line. Its Y-value and the X-values of its intersections with trace A (or B) are displayed, if available. If there are several intersections, the extreme, right-hand and the extreme, left-hand intersections are used. When changing its position via rotary knob or direction keys the cursor jumps from measured value to measured value, usually meeting exactly only 1 intersection (left or right). The other (last) intersection is no longer valid and therefore marked by an "i" in the display. With softkey B, the intersections with trace B are displayed.

Graphics	Labeling of display field	Selected softkey
	*Y *XAL *XAR	HLINE A
	*Y *XBL *XBR	HLINE B

Δ A

Δ B

The *-cursor is switched over to horizontal line. The difference between its Y-value and that of the o-cursor is displayed. The intersections with trace A or, as the case may be, trace B are displayed (see above). Application: e.g. simple measurement of the -3-dB points.

Graphics	Labeling of display field	Selected softkey
	oA-*Y *XAL *XAR	Δ HLINE A
	oB-*Y *XBL *XBR	Δ HLINE B

MARKER

A

B

MAX

With FFT only; sets the first marker (triangle marked by "X") to the maximum value of trace A (or B).

o-CURSOR

With FFT only; sets the first marker to the value defined by the o-cursor. Trace A (or B) is used.

VIEW OFF

With FFT only; deletes the first marker on trace A (or B) and the harmonics.

HARM ◉

(Harmonics) with FFT only; sets or deletes alternately the markers 2 to 9 of the harmonics (frequency multiples) of the first marker. The values of trace A (or B) are marked. With the first marker (triangle marked by "X") being on the fundamental wave, k2 to k9, for example, are marked.

CURSOR

SET TO

MIN A

MIN B

(Not with FFT). The active cursor is set to the minimum value of the sweep (in the displayed section). It is also displayed as the cursor value. The measured values of trace A (or trace B) are used.

IMAX A

IMAX B

(With FFT only). The active cursor is placed on the interpolated maximum, which may be higher than the values displayed (see 2.6.5.12 FFT). This value is displayed as a cursor value, too.

MAX A

MAX B

The active cursor is placed on the maximum value of the sweep (in the displayed section). It is also displayed as the cursor value. The Y-values of trace A (or trace B) are used.

MARKER

(With FFT only). The active cursor is placed on marker 1 of the FFT. Its value is then displayed as a cursor value.

NEXTHARM

(With FFT only). The active cursor is placed on the next marker of the FFT. Its value is then displayed as a cursor value.

MORE

SETREF

A WITH *

B WITH *

(Set Reference)
Sets the reference value TRACE A REFERENCE in the DISPLAY panel to the current value of the *-cursor. In this case, the cursor must not have HLINE function. Effective only with relative scaling units and causes trace A to be redrawn. Applies analogously to TRACE B, where SCALE B must not be set to EQUAL A.

A WITH o

B WITH o

Sets the reference value TRACE A REFERENCE to the current value of the o-cursor. In this case, the cursor must not have HLINE function. Effective only with relative scaling units and causes trace A to be redrawn. Applies analogously to TRACE B, where SCALE B must not be set to EQUAL A.

2.10.3 Parameters for the Display of Lists

TRACE A

Used to select the measurement results that are to be collected during a sweep as TRACE A (or TRACE B) and which are then displayed as a list of numbers in the GRAPHICS panel (graphics window).

TRACE B

FUNC CH1

(Function channel 1)
The results of the current measurement of channel 1, which has been selected in the ANALYZER panel by way of FUNCTION, are used. Possible only when FUNCTION in the ANALYZER panel is not OFF.

FUNC CH2

As above, however of channel 2.

FREQ CH1

(Frequency Channel 1) Frequency meter channel 1. Possible only when FREQ/PHASE in the ANALYZER panel is not set to OFF.

FREQ CH2

Frequency meter channel 2. Possible only when FREQ/PHASE in the ANALYZER panel is set to FREQ.

PHASE

Phase meter between channel 1 and 2. Possible only when FREQ/PHASE in the ANALYZER is set to FREQ&PHASE.

HOLD

Does not collect any new values but holds the old ones.
HOLD is only accepted as input if valid trace data or FFT data are provided.

OFF

Switches the display in the form of a list off.

FILE

DUAL FILE

A sweep stored to file in the FILE panel (STORE TRACE/LIST) can be recalled and displayed, e.g. for comparison purposes, using this option. The subsequent menu line is required for this purpose.
Also see 2.10.1, Trace A/B FILE and DUAL FILE.

GROUP DELAY

The group delay calculated from the phase is used.

FILE NAME

(Displayed with TRACE A/B FILE only). Enter the name of the file with a sweep or FFT to be displayed. If any error occurs during loading, "NOT FOUND" is output in this line.

UNIT

Determines the unit with which the results are to be displayed (see also Section 2.4 Units). Recorded sweeps can be reprinted at any time using any other unit.

When, after selection of a new function or a new instrument, the present unit can no longer be used, the units set for the measurement in the ANALYZER or GENERATOR panels are automatically adopted for the new function.

REFERENCE

The reference value is required for the relative units and the limit curves.

MAX

The maximum value of the sweep is adopted once as reference value.

o CURSOR

The value the cursor is placed on is adopted once.

VALUE:

A numeric value with unit is entered.
Further settings see under 2.10.1 Reference ...

...

2.10.4 Display (GRAPH) of Lists

The results of an FFT or a sweep are output as numeric values using SPECTR LIST or SWEEP LIST. TRACE A, TRACE B and X AXIS are displayed in 3 columns which are complemented by a fourth column in which measurement results exceeding the UPPER or LOWER LIMIT curve are indicated by way of arrows (triangles) pointing upward or downward. To this end, LIMIT CHECK must be activated in the FILE panel. In full-screen graphics mode, the LIMITS, if active (LIMIT CHECK not OFF), are indicated in additional two columns (interpolated in the case of intermediate values).

The symbol for the o-cursor is displayed in the left edge of the screen in the line with the value on which the cursor is placed (also with trace presentation). After a new picture has been set up the cursor is placed in the center and can be moved using the rotary knob or the direction keys. When the cursor reaches the edge of the picture, the display is scrolled line for line. Any new sweep deletes an old line replacing it by a new line.

As opposed to SWEEP OR SPECTR **LIST**, **LIM REPORT** displays only those measured values exceeding the upper tolerance mask (LIMIT UP) or the lower tolerance mask (LIMIT LOW). LIMIT CHECK must be activated in the FILE panel for this purpose. Any new sweep deletes the old display completely and sets it up anew from top to bottom. If there are more lines than can be displayed on the screen, the picture segment can be shifted using the rotary knob or the direction keys.

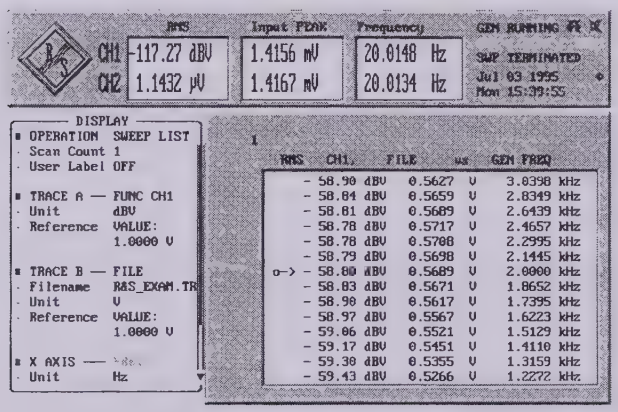


Fig. 2-40 Page/ up/down : scan select

2.10.5 Parameters for BARGRAPH Display

BARGRAPH1

Used to select the measurement results that are to be indicated as bargraph.

BARGRAPH2

FUNC CH1	(Function channel 1) The results of the current measurement of channel 1, which has been selected in the ANALYZER panel by way of FUNCTION, are used. Possible only when FUNCTION in the ANALYZER panel is not OFF.
FUNC CH2	As above, however of channel 2.
FREQ CH1	Frequency meter channel 1. Possible only when FREQ/PHASE in the ANALYZER panel is not set to OFF.
FREQ CH2	Frequency meter channel 2. Possible only when FREQ/PHASE in the ANALYZER panel is set to FREQ.
PHASE	Phase meter between channel 1 and 2. Possible only when FREQ/ PHASE in the ANALYZER is set to FREQ&PHASE.
OFF	Switches the display off
GROUP DELAY	The group delay calculated from the phase is used.

BARGRAPH X

Displays the x-value of the current sweep. If no sweep is active, the display contains, if possible
the phase, if phase measurement is switched on
frequency of channel 1 or channel 2 or generator frequency (if selected generator function allows for frequency input),
if frequency measurement is switched on

UNIT

Determines the unit with which the results are to be displayed (see also Section 2.4 Units).

REFERENCE

The reference value is required for the relative units.

MAX	The maximum value is adopted once as reference value.
VALUE	A numeric value with unit is entered.
...	Refer to Section 2.10.1 Reference ... for further settings.

Scale

AUTO ONCE

Uses the minimum and maximum values for scaling (once) and rescales after changing the function using FUNCTION in the ANALYZER panel or TRACE A/B in the DISPLAY panel. The menu items LEFT and RIGHT are no longer displayed because they have been set in doing so. For BAR 3, the sweep start/stop values are adopted from the GENERATOR or ANALYZER panel.

MANUAL

Leaves the subsequent scaling to the user.

SPACING

LIN

Linear spacing of the display axis.

LOG

Logarithmic spacing of the display axis. With logarithmic units (dB) selected in UNIT, LIN only can be selected.

LEFT/BOTTOM

(With SCALE MANUAL,) sets the bottom left value of the display. Negative or 0-values are not permissible in combination with SPACING LOG or logarithmic (dB) units.

RIGHT/TOP

(With SCALE MANUAL,) sets the top right value of the display. The value must be higher than that of LEFT. Negative or 0-values are not permissible in combination with SPACING LOG or logarithmic (dB) units.

AUTOSCAL

ALL

Rescales the axes of BAR1 and BAR2 using the current maximum values of the measurement and BAR3 using the sweep start/stop values. If there are no measured values, the range limits are used.

BAR1

Only BAR1 is rescaled (otherwise as ALL).

BAR2

Only BAR2 is rescaled (otherwise as ALL).

BAR3

Only BAR3 is rescaled (otherwise as ALL).

2.10.6 BARGRAPH Display (GRAPHICS Panel)

BARGRAPH indication is used to display the current measured values in analog form as bars. Bargraph display is suited for applications in which the relative magnitude or changes in magnitude are significant and not the exact value. A maximum of 3 bargraphs can be displayed. Values exceeding the displayable range are indicated by a triangular arrow on the left or right side.

The peak values measured in the monitoring interval (after Start) are marked by a pointer, identifiable by the thin line, its left end marking the minimum value, the right end the maximum value. The pointer can be reset using the Start key.

With limit check activated in the FILE panel (LIMIT not OFF), also the limit values (interpolated in the case of intermediate values) are displayed in the form of brackets. When changing the independent axis (e.g. the frequency with sweeps), the brackets are automatically set to the appropriate values. The bargraph changes its colour when the limits are exceeded.

The minimum and maximum values during the monitoring interval are displayed as numeric values above the bargraphs. In full-screen mode, the difference between maximum and minimum value is indicated, too.

BARGRAPH3 represents the current X-value of the set sweep, the measured frequency or phase or the generator frequency. The field remains empty when no sweep is started.

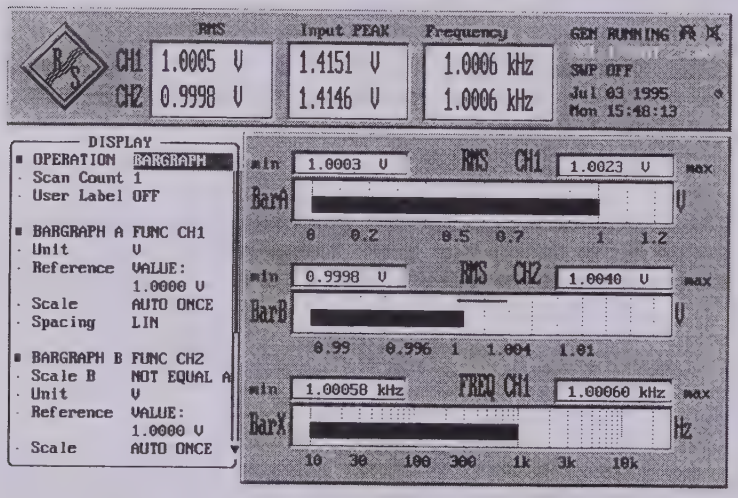


Fig. 2-41 Bargraph display

2.10.7 Limit Check

The following commands are available under the heading LIMIT CHECK in the DISPLAY panel which is called by pressing the DISPLAY key or the key combination Alt-D on the external keyboard.

A lower and an upper limit or, as the case may be, a limit curve can be defined for the measurement, each measured value of a sweep or an FFT being compared with the limits. With trace display, they are included in the coordinate system; with bargraph indication, they are marked by lines (varying in position). With SWEEP LIST, lines containing measured values out-of-tolerance are marked by a triangle. With LIM REPORT active, measured values violating the limits are indicated or stored. (See also OPERATION command in the DISPLAY panel in Section **2.10** and STORE TRACE/LIST in the FILE panel in Section 2.9.1.2.)

With CURVE PLOT, exceeding of limits is marked in the top, left edge by an arrow pointing downwards (lower limit is violated) or by an arrow pointing upwards (upper limit or limit line is exceeded). A single exceeded limit marks the whole sweep as out-of-tolerance. Unlike underrange values, overrange values (measured with overdriving) are out-of-tolerance values.

When relative units are used, the limits are converted using the reference value in the DISPLAY panel.

Check

Determines which trace (or bargraph) is checked.

TRACE A

TRACE B

Either trace A (or BARGRAPH 1) or trace B (or BARGRAPH 2) can be checked.

TRACE A + B

Both curves are checked together for a limit violation. As there is only one tolerance band, this is only useful if the measured physical quantity is the same. To ensure that this is the case, this selection item is only be available when "Trace B EQUAL A" is selected. The reference value of trace A is used.

Mode

LIM LOWER The lower limit is checked.

LIM UPPER The upper limit is checked.

LIM LOW&UP The lower and upper limits are checked.

OFF Limit check is OFF.

Lim Upper

Lim Lower

Determines how the lower/upper limit value is defined.

VALUE

A value with unit which is constant for all X values is entered for the upper/lower limit. If a relative unit is entered, the appertaining reference value is taken from the DISPLAY panel (TRACE A/B REFERENCE).

OFF

A lower/upper limit curve is defined below.

Filename

This serves to load the file with the limit curve. If mode LIM LOWER or LIM LOW&UP is switched on, the curve for the lower limit can be loaded, which contains the extension .LLW to the file name. In mode UPPER or LIM LOW&UP, this is the file with extension .LUP.
These files contain x-y pairs, with the y-value being a factor which is multiplied with the set reference value (TRACE A (or B) REFERENCE VALUE from the DISPLAY panel) to obtain an absolute value. By changing the reference value, the tolerance band on the y-scale can be offset. The following measurements are relative measurements, which is why there is no reference value and only the units % and dB: THD, THD+N, MOD DIST, DFD, WOW&FL.
The limit value must be entered in %, e.g. 5 for 5% for the upper limit value, a lower limit (LIM LOWER) being not required.

Only a few sampling points are required. The intermediate values necessary for tolerance monitoring of a sweep or an FFT are interpolated at the start of a sweep. This requires an indication whether the axes for x and y are linear or log, to ensure that correct values are calculated for segments not running horizontally or vertically (slanted segments). These lines become elliptical in the other division. If points are required before or after the last sampling point, the last slopes of the interpolation are continued.
In the case of full-screen mode, the interpolated limit values are indicated for every measured value in the graphics window with OPERATION SWEEP/SPECTR LIST or SWP/SPC LIM Report.

Note: *The file format is described in the example data R&S_EXAM.LLW and R&S_EXAM.LUP in the form of comments. The parameters of the measured points are arranged in blocks one after the other, i.e. first the y-values then the x-values. In the files R&S_E212.LLW and R&S_E212.LUP the parameters of the measured points are arranged in pairs, i.e. y- and x-values in one line.*

2.10.8 PROTOCOL Analysis

When a digital analyzer is used, the audio data contents can be monitored and displayed as well as the transmitted information analyzed. The latter is the channel status and user data, the meaning of which depends on their application and protocol. Additionally, this protocol analysis includes display of other (transmission) errors. To activate the protocol analysis, PROTOCOL measurement function must be selected in the ANALYZER panel (see 2.6.5.15).

Screen display:

The screen (consisting of 16 lines of 50 characters each) is divided into two sections:

TOP: Fixed protocol elements:

Validity: shows the state of the validity bit in the respective channel. If the two channels are equal, L=R is indicated in addition.

Parity errors: indicates the error status (yes/no).

Errors: indicates the errors that have occurred:

LOCK:	PLL not locked
CONFIDEN:	cannot be decoded (eye opening less than half a bit)
CODING:	coding error detected
NONE:	no error

BOTTOM: These 13 lines can be matched to the currently used protocol with the aid of a protocol control file.

Changing status bits are displayed and output in red.
Bits that have not changed since the latest output are displayed in green.
Comments (PRINT command) are displayed in yellow.Example:

Protocol Analysis: Channel Status Left

Validity: L=R 1=Y			Parity errors: _____		
			Errors: NONE		
Byte:	= = = = = = = =	AES3	= = = = = = = =		
0:	Format:	prof	Mode:	audio	
	Emph:	J.17	Source:	locked	
	Rate:	48kHz			
1:	Chanmod:	stereo	Usermod:	AES18	
2:	Auxmod:	20 no	Length:	23	R:0
3-5:	Vector:	12	Grade:	2	R:0
6-13:	Origin:	UPL _	Destin:	R&S _	
14-21:	Local:	01234567	Time:	12:45:00	
22:	Relia:	0-5:1 6-13:0	14-17:0	18-21:0	
23:	CRC L:	_____	CRC R:	_____	
Measured sample rate: 48000.2					

↑ Text entered by UPL

↓ From here: user-defined

This example was generated with the protocol file R&S_aes3.pac.

Source Select the data to be displayed.

- **CHAN STAT L** Channel status data left are displayed.
- **CHAN STAT R** Channel status data right are displayed.
- **USER L** User data left are displayed.
- **USER R** User data right are displayed.

With CHAN STAT L or R, the following line is read out on the screen:

Proto File

Proto File selects the interpretation file for channel status data.
Selection from: file name, preset type of file: *.pac

Description:

The protocol information is displayed in two sections; the two upper lines are displayed in a fixed format and contain information on validity, parity, other errors and differences between the two channels. The other lines are formatted using the specifications in the file, the individual bits being assigned any output text you desire. This file can be modified to suit any protocol you desire.

Example: see R&S_AES3.PAC

File format: same as with USER L or USER R, see below

With USER x, the following lines are displayed:

FORMAT Format selects the interpretation mode.

- **BINARY** User data are represented in a 01010 sequence. Representation is block aligned.
- **HEX** User data are represented as a hexadecimal, numerical sequence. Representation is block aligned.
- **ASCII** User data are represented as text. Representation is block aligned.
- **FILE** Interpretation, block aligned

With FILE, the following line is displayed:

Proto File

Proto File selects the interpretation file for user data.

Selection from: file name, preset type of file: *.PAU

File format:

The protocol file has the following structure:

One line for each operation, followed by parameters which are separated by commas. The parameters allow the representation of any bits (1 to 32) from the selected data, the output position being freely selectable. Each line must not contain more than 255 characters.

Operations:

PRINT: Text output (independent of data)

Example:

PRINT 26, 5, "Usermod:"

(in column 26, line 5 the text "Usermod:" is entered)

VALUE: Output of values, either as hex number (default) or as text provided that an assignment is present.

Example:

VALUE 17, 3, BIT:2-4, 0="not ind", 4="no empf", 6="50/15 "

(in column 17, line 3, the contents of the three bits (2,3,4) are represented as hex (or text, in case the value is 0, 4 or 6)

VALUE 17,11, CRC – L – ERR

(in column 17, line 11, the contents of the CRC left frequency counter is represented)

Note as to the output width:
If there are text assignments, the longest text determines the output width; In case there are no text assignments, the number of bits to be represented determines the output width.

As a data source, the following specifications are permissible:

- 'BIT' followed by ':' and definition of the bits:
  - a number from 0 to 191: single bit
  - an interval (e.g. 4-9): combined sequence of bits, max. 32 bits permissible
- 'CRC_L_ERR': error indication of CRC_error left.
- 'CRC_R_ERR': error indication of CRC_error right.
- 'MEASURED_RATE': measured sample rate (represented as a 5.1-digit floating number
  (e.g. '48001.2')

BINARY: same as VALUE, however default output as bit pattern

TEXT: Text output (in ASCII) using a number of letters determined by the number of selected bits; each TEXT operation allows only 32 bits to be represented; for longer text outputs, several subsequent text lines are to be used.

Example:

TEXT 17, 8, BIT:48-79
(in column 17, line 8, the contents of the 32 bits is represented as text)
Characters that cannot be printed are replaced by '?' or, if '0', by '.' .

TIME: Time output (in the form of 12:45:56) of the selected number divided by the specified rate. Number/rate are interpreted as seconds since midnight.

Examples:

TIME 35, 9, BIT:144-175, RATE:48000.0
TIME 35, 9, BIT:144-175, RATE:SET – RATE

(in column 35, line 9, the contents of the 32 bits are represented as time (e.g. 12:34:45)

'RATE:' Should correspond to the sample rate, can be specified as floating number.
As an alternative, the following specifications are also possible:
MEASURED _ RATE: measured clock rate
SET _ RATE: clock rate set in the panel

2.10.9 Switching between Full-screen and Part-screen Mode

Part-screen graphics mode offers the possibility of complementing the graphical representation with another panel. The large measured value display on the upper screen edge is maintained, too. In full-screen graphics mode, the graphics has been scaled up to occupy the complete screen. The only differences between part-screen and full-screen mode are the two additional columns with the limits for the output of lists (SWEEP/SPECTR LIST and SWP/SPC LIM REPORT) and the display of the difference between minimum and maximum value with BARGRAPH, which are offered in full-screen mode only.

After having selected the GRAPHICS panel using the GRAPH key (or key combination Alt-R), you can choose between full-screen and part-screen mode using the front-panel key □◄►□ (or key combination Alt-Z) or by clicking the mouse (see also 2.3 General Instructions for Use and 2.3.1 Panels).

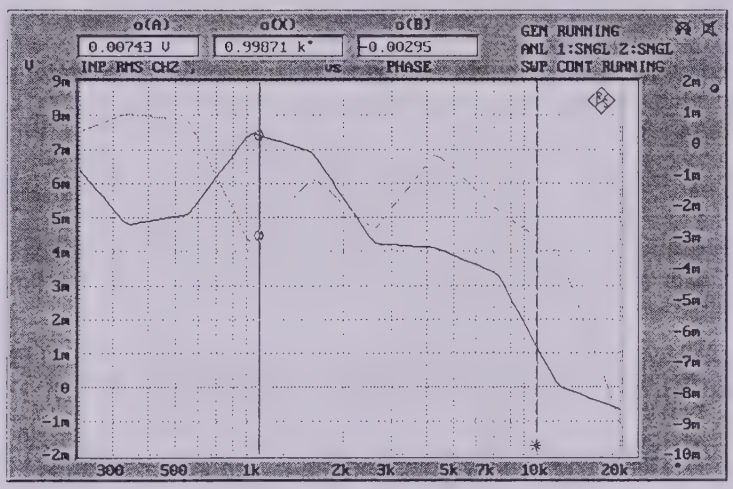


Fig. 2-42 Full-screen display

2.11 Starting and Stopping Measurements or Sweeps

2.11.1 Overview of Measurement and Sweep Systems

Basically, a differentiation is made between measurements and sweeps:

- Measurements, in the narrower sense, are understood to be single or continuous measurements of frequency, phase, input peak, or one of the measurement functions. The latter include S/N measurements, which can be activated during the AC level measurement functions (RMS, peak and quasi-peak), and in which the measurement is first performed with and then without a generator signal and the two results are then referenced to each other. The FFT function, too, is handled as a measurement, and so is the post-FFT function, which can be activated for some measurement functions although the relevant frequency lines are represented graphically or in the form of tables (similarly to sweeps).
- Sweeps are test runs in which the individual measurements are triggered by predefined generator or analyzer settings or by external events. Generator and analyzer sweeps are defined either by entering the start and stop values, the spacing and the points/step or by means of a sweep list. With both methods, a list of settings (along the X axis) is defined, which is executed after the sweep is started. In the case of generator sweeps, the list may be two-dimensional, i.e. include two variable generator parameters. This is referred to as Z sweep because the Z axis is swept in addition to the X axis. External sweeps (adjustable in the ANALYZER panel under "Start Cond"), on the other hand, have no fixed X axis. Instead, the X axis is defined by an external voltage or frequency or by a time tick. The sweep system will be activated when a sweep is switched on.

Measurements and sweeps are controlled by means of control keys START (Ctrl F5), SINGLE (Ctrl F6) and STOP/CONT (Ctrl F7), an by specific events referred to as abort events. The control keys and abort events control the measurement system when the sweep system is inactive (no sweep switched on). When the sweep system is active (generator, analyzer or external sweep switched on), the selected sweep is controlled by the control keys and abort events, and the sweep in turn controls the measurement system.

Abort event:

Definition:
Any event that renders a current measurement or sweep invalid. Occurs, if settings in the GENERATOR, ANALYZER or FILTER panels and in the relevant sections of the STATUS panel, which influence the measurement or sweep, have been modified.

Effects:

- The current measurement or sweep is aborted and restarted.
- A completed (single) measurement is restarted.
  (Note: This is valid only for manual control, no restart is done under remote or automatic control.)
- A completed (single) sweep is set "invalid" (upper right of status display).
- A completed (single) sweep normally remains unaffected in order to make it possible for the user to draw the single scans of a multiscan trace with changed UPL settings. Only if sweep settings are changed by the "abort event" (e.g. changing of start/stop, number of sweep points) the sweep is set "invalid" (status display upper right in display).

2.11.2 Switching Measurement Modes On and Off

UPL can measure up to six parameters simultaneously and display them numerically or graphically. These parameters are:

- Measurement functions of channels 1 and 2
- Input peak or rms of channels 1 and 2
- Frequency of channels 1 and 2, or frequency of channel 1 and phase difference between channels 1 and 2

Measurement modes can be switched off

- directly by user entries (channel selection, switching off of "Input Disp", "Frequency" or "Function" in the ANALYZER panel); this will be indicated by "OFF" in the window for the corresponding measured value,
- indirectly by selecting a test function, an analyzer instrument or an input that is not compatible with the selected measurement mode (measurement modes selected in the ANALYZER panel but not physically feasible, e.g. frequency measurement with the DC measurement function on, are marked by "------" in the window for the corresponding measured value).

In the (single) measurement mode, all measurement functions that are switched on and active are performed. A measurement is completed when all relevant results (including a settling period, if applicable) are available. Only then can a sweep be stepped or a triggered result be fetched in the remote control mode. This also means that the measurement speed of the UPL as a whole is determined by the speed of the slowest measurement mode or function. To achieve maximum measurement speed, it is recommended that only the measurement modes really needed be switched on.

Note: *In analyzer 110 kHz channels 1 and 2 are measured sequentially by which the measured time nearly doubles for 2 channel operation compared to 1 channel measurement.*

The display of measured values can be switched off completely irrespective of the selected measurement mode. In this case, the status displays, too, are switched off. Switch-off is effected by selecting the "Meas Disp" menu item in the OPTIONS panel or by pressing the Ctrl D hotkey on the external keyboard. Switch-off of the display results means a substantial reduction of measurement time. This mode is useful, for example, if only the generation and representation of sweep traces and spectra is of interest and not the output of individual measured values.

2.11.3 Operating States of Measurement System (No Sweep Active)

The operating states of the measurement system are displayed in the upper right corner of the

ANL WAIT FOR TRIG: The analyzer waits for the trigger condition set with START COND (cf. 2.6.4).

ANL1: 2:

Status information separate for analyzer channel 1 | 2:

OFF:	channel switched off, no status information
SNGL:	single measurement running
CONT:	continuous measurement running
TERM:	single measurement terminated
STOP:	measurement interrupted

There are further messages indicating, for example, operating states relating to running measurements (e.g. RANG) or to terminated measurements (e. g. OVER in case no valid result was obtained due to OVERRANGE).
See section 2.3.4 for further details on these status displays.

Continuous measurement:
The system operates with continuous measurements as the default mode. The UPL is set to this mode after switch-on. The UPL goes through all active measurement functions asynchronously until one of the following events occurs:

- SINGLE key is pressed: Switch over to single measurements is made. A measurement already started will always be completed. When all measurements are completed, the system stops in the TERMinated status. To reactivate the continuous measurement mode, press START or STOP/CONT.
- STOP/CONT key is pressed: The current measurement is stopped and the system is brought to the STOP status. To reactivate the continuous measurement mode, press START key or press STOP/CONT key again.
- START key is pressed: The current measurement is aborted, the non-return pointers and the min./max. values of the BARGRAPH as well as FFT averaging are reset, and the continuous measurement is restarted.
- Occurrence of an abort event (see 2.11.1): The current measurement is aborted and continuous measurement is restarted.

Single measurement:
Each type of measurement is performed only once, then the system stops in the TERMinated status. This status does not necessarily mean that a valid result was obtained. If an error occurs during a measurement, the message "Input? Press Show-IO" appears in the window for the corresponding measured value, and an NAN value (Not A Number, 9.97e37) is read via remote and automatic control. A single measurement will be restarted, after completion of the previous measurement, by pressing the SINGLE key or by the occurrence of an abort event.

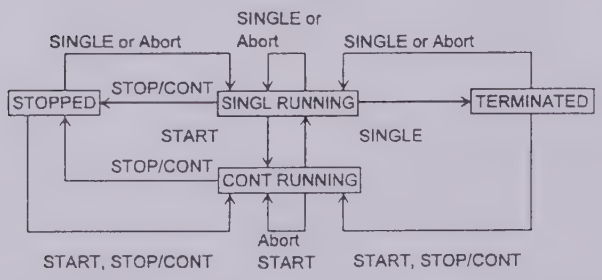


Fig. 2-42 Status diagram of measurement system (no sweep active)

2.11.4 Overview of Sweep Modes

The UPL features a variety of sweep modes which are briefly described in the following:

Predefinable sweeps:

- Generator sweeps
  - Time-synchronous sweeps (DWELL sweeps)
  - Sweeps synchronized with the analyzer (AUTO sweeps)
  - Manual sweeps (MANU sweeps)
- Analyzer sweeps
  - Sweeps synchronized with the analyzer (AUTO sweeps)

External sweeps:

- Time-tick sweeps
- Time-chart sweeps
- External frequency sweeps
- External level sweeps
- External level trigger

All of the above sweeps can be performed as single or as continuous sweeps. All predefinable sweeps can be performed as parameter sweeps with a constant increment or as list sweeps.

All generator sweeps can be performed as one- or two-dimensional sweeps (X or Z sweeps) provided that there is more than one sweepable parameter for the selected generator function.

External sweeps have no fixed X-axis. The X value for each measurement point is determined during the sweep.

One-dimensional sweeps can be performed as single sweep or as group of traces, two-dimensional sweeps can be performed as group of traces only. Single or group traces can be selected under menu item "Scan count" in the DISPLAY panel:

- With count = 1, only one trace is shown for every sweep; the old trace is successively erased as the new trace is drawn.
- With count >1, all traces recorded as from START are superimposed on top of each other. The last 17 traces are internally stored and can be rescaled if required.

With manual sweeps, the GRAPHICS panel will be activated automatically when a sweep is started. After starting a sweep, each sweep point must be triggered separately by means of the rotary knob or the cursor keys. Sweep stepping has priority over the current measurement being performed, i.e. the generator will be set to the sweep point next selected even if the previous measurement is not yet completed.

External level trigger can be regarded as an intermediate between a sweep and a measurement. On the one hand, this function behaves like an external one-point level sweep, on the other hand, the measured value is not stored in the trace buffers and therefore cannot be represented as a sweep curve or list.

2.11.5 Switching Sweeps On and Off

The various sweep modes are selected directly in the associated panels of UPL:

- Generator sweeps under SWEEP CTRL in the GENERATOR panel
- Sweeps of the tracking filters of the RMS SEL function under SWEEP CTRL in the ANALYZER panel
- External sweeps under START COND in the upper section of the ANALYZER panel

Before a sweep is switched on, it must be ensured that no other sweep is active.
If another sweep is active, an error message is output prompting the user to switch the sweep off that is not needed.
After switching a sweep mode on, the measurement system will continue to perform continuous or single measurement; only by starting the sweep will the sweep system take over and control the measurement system.
When switch-off is made during a running sweep, the system will return to the continuous measurement mode.

2.11.6 Operating States of Sweep System

The operating states of the sweep system are displayed in the upper right of screen:

SWP OFF	sweep system switched off
SWP INVALID	sweep invalid due to changes of parameters or because sweep is not yet started
SWP CONT RUNNING	continuous sweep running
SWP SNGL RUNNING	single sweep running
SWP MANU RUNNING	manual sweep running
SWP TERMINATED	single sweep terminated
SWP STOPPED	sweep was stopped, can be continued.

Continuous sweeps:
Continuous sweeps are started by pressing the START key. When the stop value of a sweep is attained, restart is made from the start value. This is continued until one of the following events occurs:

- In continuous sweeps with Scan count >1: when the number of sweep runs defined in "Scan count" is completed, the sweep system goes to the SWP TERMINATED" status.
  Note: *With Z sweeps, the number of Z-axis points is transferred to the DISPLAY panel as the lower limit of "Scans".*
- SINGLE key is pressed: switchover to single sweep is made. The trace currently drawn is completed, then the system goes to the "SWP TERMINATED" status. To reactivate the continuous sweep mode, press START key. To activate the continuous measurement mode, press STOP/CONT key.
- STOP/CONT key is pressed: the current sweep, and the system, are stopped ("SWP STOPPED status). To reactivate the continuous sweep mode, press START key (sweep is restarted), or press STOP/CONT key again (sweep is continued). To activate the continuous measurement mode, switch the sweep mode off.
- START key is pressed: the current sweep is aborted, the non-return pointers and the min./max. values of the BARGRAPH as well as FFT averaging are reset, and the continuous sweep is restarted.
- Occurrence of an abort event (see 2.11.1): the current sweep is aborted and continuous sweep is restarted.
- The sweep mode is switched off: switchover is made to the continuous measurement mode.

Exceptions:

- Level- or frequency-triggered external sweeps: trigger values that are closer to the start value by more than the difference relative to the latest measured value are detected as a retrace and the sweep is restarted.
- Level-triggered external sweeps: the level must fall below the start value after each externally triggered measurement for the level trigger to be ready for the next measurement.
- All external sweeps: when the STOP/CONT key is pressed, the current sweep is terminated (SWP TERMINATED status). Continuation of that sweep is not possible. (cf. 2.11.7 Operating Modes of External Frequency and Level Sweeps and 2.6.4 Starting the Analyzer).

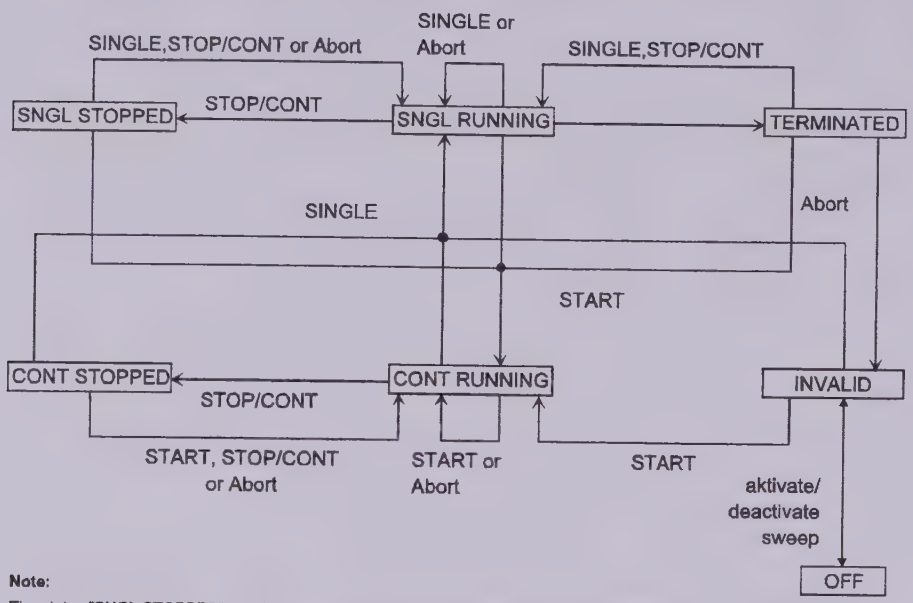


Fig. 2-43 State diagram of sweep system

Single sweeps:

Single sweeps are started by pressing the SINGLE key and are performed only once. When the stop value (of the X axis) is attained, the system goes to the SWP TERMINATED status. With Z sweeps, therefore, each new Z point (and the corresponding X-axis sweep) must be triggered separately.
A running single sweep is stopped or aborted by one of the following events:

- SINGLE key is pressed: the current single sweep is aborted and then restarted.
- STOP/CONT key is pressed: the current measurement and the sweep system are stopped (SWP STOPPED status). To reactivate the single sweep, press SINGLE key (sweep is restarted), or press STOP/CONT key again (sweep is continued).
- START key is pressed: the current sweep is aborted, the non-return pointers and the min./max. values of the BARGRAPH as well as FFT averaging are reset, and continuous sweep is started.
- Occurrence of an abort event (see 2.11.1): the current single sweep is aborted and then restarted.
- The sweep mode is switched off: switchover is made to the continuous measurement mode.

After termination of a single sweep, the following can happen:

- SINGLE key is pressed: the single sweep is restarted.
- STOP/CONT key is pressed: switchover is made to the continuous measurement mode. To reactivate the single sweep, press SINGLE.
- START key is pressed: the non-return pointers and the min./max. values of the BARGRAPH as well as FFT averaging are reset, and continuous sweep is started.
- Occurrence of an abort event: the sweep system goes to the SWP INVALID status.
- The sweep mode is switched off: switchover is made to the continuous measurement mode.

Deviating from these general status transitions, there are the following **special conditions** for some sweep modes:

- Level- or frequency-triggered external sweeps: trigger values closer to the start value than the last measured value are ignored. Trigger values beyond the stop value cause the current single sweep to be terminated (resulting in SWP TERMINATED status).

- Level-triggered external sweeps: a single sweep is considered terminated following the first externally triggered measurement (resulting in SWP TERMINATED status). Pressing the SINGLE key makes the level trigger ready for the next trigger event.

- All external sweeps: when the STOP/CONT key is pressed, the current sweep is terminated (SWP TERMINATED status). Continuation of that sweep is not possible.

Summary: key functions

START

Start continuous or manual sweep (only with active sweep system, see 2.5.5.2 Sweeps) and active measurements.

Sweep system active:
Resets sweeps (peak-, average values and non-return pointers are reset and graphical representation deleted) and starts sweeps; new state: RUNNING
With manual sweep selected, any new sweep setting must be triggered using the rotary knob.
While the sweep is running, any entries in the GENERATOR, ANALYZER or FILTER panel or in the corresponding sections in the STATUS panel cause the sweep to be aborted. Permissible keys (not changing the state):
- softkeys
- rotary knob

Sweep system inactive (sweep state OFF):
Resets measurements (averaging, peak-, average values and non-return pointers are reset) and (re)starts continuous measurement.

SINGLE

Sweep system active:
In the sweep states SNGL RUNNING, MANU RUNNING, STOPPED, TERMINATED or INVALID:
- Starts a single or manual sweep

In the sweep state CONT RUNNING:
- Switches from continuous to single sweep

Sweep system inactive (sweep state OFF):
Key refers to single/continuous measurement:
- Analyzer state SNGL RUNNING, STOPPED or TERMINATED: starts a single measurement

- Analyzer state CONT RUNNING: switches from continuous to single measurement.

Sweep system active:
In the sweep state CONT RUNNING or SNGL RUNNING
➢ Aborts the sweep; new state: STOPPED

➢ Analyzer is switched to "wait for trigger".

In the sweep state STOPPED:
➢ Continues the sweep without reset; new state: SNGL RUNNING or CONT RUNNING

In the sweep state INVALID or TERMINATED:
➢ Continuous measurement is started.

Sweep system inactive (sweep state OFF):
Key refers to single /continuous measurement

➢ Analyzer state ...RUNNING: aborts the measurement immediately
➢ Analyzer state STOPPED or TERMINATED: starts continuous measurement.

2.11.7 Operating Modes of External Frequency and Level Sweeps

With external sweep, the analyzer has to decide independently, whether a new measured value is applied, which is to be recorded and displayed. It is important that the x-axis is continuously rising or falling. A reversal of the sweep direction must be interpreted as retrace or ignored. The question is: when does a new sweep begin and what are "outliers" which can be ignored.

The following settings are of importance for an answer:

Start condition
Stop condition
Possibly settling
Starting the measurement using the START key
Terminating the measurement using the STOP key

• An external sweep which is started using the **SINGLE** key starts as soon as the start condition is reached and terminates after the stop condition has been reached. TERMINATED is then displayed, i.e., the sweep is terminated. In order that the end of an external sweep will be recognized, the stop condition must be set such that it can be recognized with certainty. For example, by a frequency sweep up to 20 kHz, the stop condition must be set a little before 20 kHz, which means that the entire length of the sweep cannot be acquired. With a single measurement, measured values are only plotted in ascending order. Stray measurement values which would lead to a backward signal are ignored. In this operating mode, it is recommended to set Scan count to 1 in the DISPLAY panel.

• An external sweep which is started using the **START** key starts as soon as the start condition is reached and is not terminated automatically. Every discontinuity in the measurement sequence or the reaching of the stop condition causes the actual sweep to be aborted. If the start condition is again satisfied, the trace up to this point is completely deleted and a new sweep is plotted. In this operating mode it is thus not allowed that an external sweep contains any stray measurement values which would lead to a backward signal. If the stop condition is set such that it is never reached (e. g. to 25 kHz when the sweep only goes up to 20 kHz), the external sweep is actually plotted up to the last measured point. If several external sweeps should be measured in a quasi-continuous operating mode and displayed, the display mode Scan count >1 must be selected in the DISPLAY panel. Each new sweep start then increments the scan index, all sweeps are simultaneously displayed and can be evaluated.

2.11.8 Several Sweep Traces Displayed in a Diagram

To be able to compare different sweeps, it is useful to display them in a single diagram. This can be done in different ways in the DISPLAY panel:

Note: *Unless specified otherwise, a generator frequency sweep without Z sweep is assumed for all examples:*

SWEEP CTRL AUTO SWEEP
X axis FREQ
Z axis OFF

1. Two separate traces can be displayed with an identical or different Y axes. Each trace may contain up to 17 single scan curves. Provided they contain dimensioned values, the traces may be referenced to each other so that the deviation of each sweep point can be directly read (e.g. in dB).

   TRACE A FUNCT CH1
   Unit dBr
   Reference OTHER TRACE
   TRACE B FUNCT CH2
   Unit V
   Reference VALUE
   Trace B is displayed in V, Trace A is referenced to Trace B and displayed in dBr.

2. A trace file containing the sweep trace or a trace group of a previous (reference) measurement can be loaded into each of the two traces. Thus it is possible to compare

   – a currently measured sweep trace to a reference trace, or

   TRACE A FUNCT CH1
   TRACE B FILE
   Filename ref2trcb.trc (contains 1 mono scan, for instance))

   – two previously measured and stored sweep traces.

   TRACE A FILE
   Filename ref2trca.trc (contains 1 mono scan, for instance)
   TRACE B FILE
   Filename ref2trcb.trc (contains 1 mono scan, for instance)

3. Each trace can be referred to a reference trace. In this case the trace is displayed with the selected *relative* unit. Two traces of this kind can be simultaneously displayed in one diagram.

   TRACE A FUNCT CH1
   Reference FILE
   Filename ref3trca.trc (contains 1 mono scan, for instance)
   TRACE B FUNCT CH2
   Reference FILE
   Filename ref3trcb.trc (contains 1 mono scan, for instance)
   The SINGLE key starts a 2-channel sweep measurement

4. Within one trace, a group of up to 17 scans can be processed, i.e. rescaled and stored. Any number of scans can be displayed; the number can be specified under Scan Count. Each scan can be triggered using the SINGLE key. After each scan (TERMINATED is indicated as sweep status), the user may not only change settings on the DUT but also any parameter on the UPL (except sweep parameters). Thus it is possible, for instance, to record a scan in another measurement mode (THD all even, THD all odd) or with another measurement function (THD, THD+N), provided the basic unit of the measurement function is not changed. (It is not possible, for instance, to make up a trace with scans of RMS measurements and THD measurements.) The measured curves can also be stored as a single trace.

Scan Count	3
FUNCTION	THD
Meas Mode	ALL EVEN
SINGLE key starts scan #1	
Meas Mode	ALL ODD
SINGLE key starts scan #2	
FUNCTION	THD+N/SINAD
Meas Mode	THD+N
SINGLE key starts scan #3	

Notes:

- *If Scan Count > 17 is selected, only the last 17 of the recorded scans can be processed. Previous scans are only visible on the screen and lost during rescaling or storing..*
- *Pressing the START key clears all previously recorded or loaded scans.*
- *To clear previous scans and to record a single one, press the START and then the SINGLE key*

5. Using the SINGLE key, scans may be added to a multiscan trace or individual scans can be replaced, provided a valid sweep is set. By loading a stored (reference) multiscan trace (dual traces are also possible), a new sweep measurement can be added to the curves of a reference trace (and stored).

Scan Count	10	
TRACE A	DUAL FILE	
Filename	ref5trc.trc	(contains 5 stereo scans, for instance)
TRACE A	FUNCT CH1	
SINGLE key starts scan #6		

Note: *Pressing the START key clears all previously recorded or loaded scans.*

6. Single scans can be loaded together with a measured or loaded multi- or single-scan trace provided the X and Y axes are compatible.

Scan Count	10	
TRACE A	DUAL FILE	
Filename	ref5trc.trc	(contains 5 stereo scans, for instance)
Filename	ref61trc.trc	(contains 1 stereo scan, for instance)
Filename	ref62trc.trc	(contains 1 stereo scan, for instance)
Filename	ref63trc.trc	(contains 1 stereo scan, for instance)
Filename	ref64trc.trc	(contains 1 stereo scan, for instance)
Filename	ref65trc.trc	(contains 1 stereo scan, for instance)

This (stereo) multiscan made up to 10 stereo scans can be stored again under a new file name (under STORE TRACE A+B in the FILE panel).

Note:

When combining a multiscan and several single scans, the multiscan must be loaded first. Combining two or more multiscans is not possible.

7. Single scans can be loaded or recorded together with an existing Z sweep. For this purpose Z sweep must be switched off in the GENERATOR panel after completion and Scan Count be increased by the number of additional scans.

Z axis	VOLT	(in GENERATOR panel)
POINTS	10	(in GENERATOR panel)
Scan Count	10	(display only)
TRACE A	FUNCT CH1	
TRACE B	FUNCT CH2	

The START key triggers the Z sweep. When the sweep is terminated:

Z axis	OFF	(in GENERATOR panel)
Scan Count	12	
TRACE A	DUAL FILE	
Filename	ref71trc.trc	(contains 1 stereo scan)
Filename	ref72trc.trc	(contains 1 stereo scan)

Note:

Only single scans (mono or stereo) can be recorded or loaded with a recorded or loaded multiscan.

8. When a setup stored as ACTUAL+DATA contains a complete sweep, the setup is loaded with all its recorded sweep traces. The sweep can be continued with the SINGLE key provided a sufficiently high Scan Count has been set.

   Thus an ACTUAL+DATA reference setup can be created, for instance, to which the sweep trace of the DUT can be added. This new trace group can of course be stored again as an ACTUAL+DATA setup or as a multiscan trace file.

   Note:

   The START key clears all previous sweep traces.

2.12 Display of Selected Inputs / Outputs

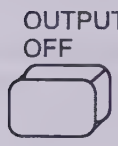
SHOW I/O

Shows a picture of the UPL front panel; the active inputs and outputs are marked by arrows.

The LC display shown indicates which inputs and outputs have been selected on the UPL rear panel.

Pressing the key while the message "Input? Press SHOW I/O" is being output in (at least) one of the measured value displays causes the messages on measurement errors, which may have occurred, to be displayed, too (see Section 2.3.6 Error Messages).

2.13 Fast Switch-off of Outputs



Switches off all outputs (incl. the clock lines of the digital interfaces).
To protect the analyzer input after overloading (input voltage into 300 Ω and 600 Ω higher than 25 V), the generator output is automatically switched off and the OUTPUT OFF LED lights as if the OUTPUT OFF had been pressed..

States:
- The level of the digital outputs is set to 0 V; no clock.
- Analog outputs are terminated (impedance is retained); output level = 0 V.
- Digital inputs supply no clock.

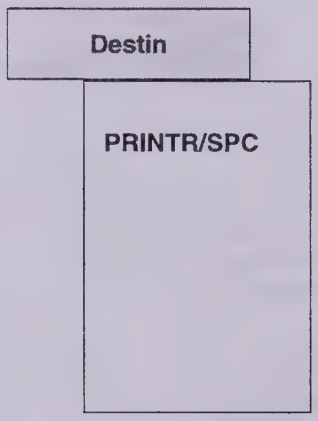
When switched off, the lines can be reactivated only by pressing the OUTPUT OFF key again. After an overload of analyzer inputs, measurements can be continued if the overload has been eliminated and the input impedance switched to 200 kΩ.

An LED indicates the state of the key. LED on signifies OUTPUT OFF. Additionally the generator status display indicates "Output Off", so this state is noticable in case of using an external monitor and no attention is payed to the UPL .

2.14 Printing / Plotting / Storing the Screen Contents

Use the H COPY (hardcopy) key on the front panel to initiate printing, plotting or storing to file of the screen contents displayed at the instant the key is pressed.

The following menu items are available in the OPTIONS panel under the heading SCREEN HARD COPY.



(Destination) indicates where and in which format the printout should be performed. The printout is triggered with the H COPY key (see below):

Graphics are output in the form of pixel data to a printer using its special print format (abbreviation **SPeC**ial). Printing is performed in the background while the UPL is accomplishing other tasks.

Note: *Printing is in progress in the background while the UPL is performing further measurements. This output can be accelerated by stopping the measured value output or the sweep using the STOP/CONT key.*

Destin (*continued*)

PLOTTR/HPGL

Control characters are output in HP-GL format, a language specifically defined for plotters, yet also supported by some printers (see Destin = PRINTR/HPLG below). HP-GL format offers the advantage of the resolution being determined by the output unit instead of by the UPL screen (slashes without disturbing stages). The size of the output is defined by the configuration of e.g. the plotter as all vectors are plotted relative to the configuration (see under P1, P2 "point" and "size/rotate" in the plotter manual).

FILE/PCX

Screen hard copy to a file using PCX format.
The PCX format (pixel format) was defined by the ZSoft company for PC Paintbrush and is accepted by most programs capable of loading graphics (MS WINDOWS programs and others).

FILE/HPGL

Screen hard copy to a file using HP-GL format.

Apart from most plotters (eg R&S DOP 2), some laser printers and some programs with graphics import capabilities also understand the HP-GL format. It is vector-oriented and offers the advantage of the resolution being determined by the output unit instead of by the UPL screen (slashes without disturbing stages). In addition, the size of the output is defined by the configuration of eg the plotter as all vectors are drawn relative to the configuration (see also plotter manual).

Note: *If HPGL data are to be used as a drawing in other programs, the result obtained is not always optimal. A few widespread (Windows) programs ignore e.g. the text format instructions or do not properly present the colour and the dashed lines. Therefore, programs are available on the market for matching and printing purposes.*

PRINTR/HPGL

Screen hard copy to a printer using HP-GL format.
Control characters are output in HP-GL format, a language specifically defined for plotters, yet also supported by some printers.
In most cases printers have to be enabled to interpret HPGL information by a sequence. This prolog is provided in a prolog file with the name GL_PRO.LOG. There is also a file with the name GL_EPI.LOG for the epilog. These files are located in the UPL\REF directory and may be changed by the user. For each character to be sent the files contain 1 - 3 (ASCII-) characters with following space interpreted as 1 Byte in decimal notation. As example the files HPLJ3_P.LOG and HPLJ3_E.LOG are delivered which initialize and reset the printer laserjet3 as desired.
All files mentioned can be found in the subdirectory \UPL\REF.

PRINTR/PS

Screen hard copy to a printer using PostScript format.

FILE/PS

Screen hard copy to a file using PostScript format.

FILE/EPS

Screen hard copy to a file using encapsulated PostScript format.
Colors and line styles for PostScript Outputs see 2.14.4.1 PostScript Configuration File PS.CFG

Copy

(With Destin PLOTTR/HPGL, FILE/HPGL, PRINTR/HPGL, PRINTR/PS, FILE/PS and FILE/EPS only)

SCREEN

The complete screen contents is output, including all labels and cursor displays as well as the curves/bargraphs with scales. In part-screen graphics mode, the display of the current measured values and a panel are additionally included. The softkeys and operator guidance line are masked out and replaced by date, time and R&S logo.

CURVE/GRID

The curves/bargraphs including the scales and scale labels are output, however not the cursors and other labels.

CURVE

The curve(s) displayed on the screen are transmitted only, thus reducing the time required for output.

Note: *If the 3-panel display is selected, an UPL PostScript copy is* ***not*** *prepared for CURVE/GRID and CURVE (empty space) as this display does not contain a trace.*

Default: SCREEN

Printname

(With Destin PRINTR/SPC only)

drivername

For most laser and ink-jet printers as well as for dot-matrix printers with 9 or 24 pins, a printer driver can be selected as described below which converts the internal graphics (pixel-) format into control characters for the connected printer with graphics capabilities.
To print out in colour, select the appropriate colour printer (colour). Otherwise select the type (B/W). The R&S PDN printer corresponds to the type Fujitsu DL 2000 series.
If the new printer drivers, version 2.11 and later are used, it is possible that the size of figures printed out will be different than they previously were. The size of the print-out can be set by selecting a different resolution with the new command Prn Resol and the commands X Scaling and Y Scaling. The size of the print-out can be read out in cm with Prn Width and Prn Height. Because it is possible that a changed resolution Prn Resol can change the background colour of the frame of the GRAPH panel and of the measurement result display field such that any text no longer stands out enough, the colour of the background can be switched to white using the new command Frame Col.

Printer 0 (default printer) has a particular meaning. It represents the printer which the user selected last. Loading a setting from file (SETUP) does not overwrite the type selected by the user, if this printer 0 is set in the setup.

Note: *Printing is performed in the background while the UPL is already carrying out further measurements. To speed up the output, stop the measured value output or the sweep using the STOP/CONT key.*

FrameCol

WHITE

FILE DEF

(Only with Destin = PRINTR/SPC, FILE/PCX, PRINTR/PS, FILE/PS, FILE/EPS)

Selecting the background colour of a GRAPH panel frame and the measurement result display for printing out the display contents or copying them to a file.

WHITE should be selected if a grey background is too dark for easy reading.

Colour defined in files.
Destin = PRINTR/SPC, FILE/PCX
Colour No. 2 (backgrnd frames) defined in files UPL\REF\PRN_BW.PLT (BW printer) or \UPL\REF\PRN_CL.PLT (colour printer) is used.
Destin = PRINTR/PS, FILE/PS, FILE/EPS
The colour information for the frames of the GRAPH panel is taken from the PostScript configuration file \UPL\REF\PS.CFG, key word "Background Frame Color" .

Default: WHITE

Comment

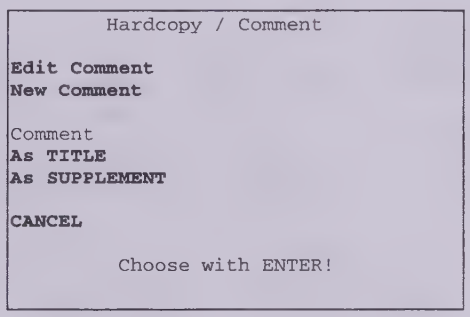
ON

OFF

(Only with Destin PRINTR/SPC, PRINTR/PS, FILE/PS, FILE/EPS)
Defines if a comment is to be printed together with the screen contents.

Destin = PRINTR/SPC:
After pressing H COPY (CTRL F8), a selection box appears with the following options: create comment, edit comment, and generate screen hardcopy.

Destin = PRINTR/PS, FILE/PS, FILE/EPS
Pressing the HCOPY key causes a window to be opened, where text can be entered or edited and a selection can be made whether the text should be inserted as a headline (TITLE) **above** the UPL plot or as a comment (SUPPLEMENT) **below**:



TITLE and SUPPLEMENT cannot be entered simultaneously.

Two text lines in Times New Roman Bold are reserved for the TITLE. A variable number of text lines (5 to 28) in Times New Roman can be entered as a SUPPLEMENT, depending on the orientation (PORTRAIT | LANDSCAPE) and the selected number of plots per page (Plots/Page). (See gray areas in the drawing under plots/page further down).

After pressing H COPY, a screen hardcopy is generated without a comment.

Default: ON

Left Mrgn

(Only with Destin PRINTR/SPC)
Margin of a hard copy

Specified range: 0 to 80 characters

Note: *Not all printers support the positioning of the graphics printout!*

Default: 10

Prn Resol

LOW

MEDIUM

HIGH

(Only with Destin PRINTR/SPC)
Whether a resolution can be set and which one depends on the printer used. The resolution affects the size of the printing format. The actual size of the printing format is shown in the lines Prn Width and Prn Height.

Low resolution (*e.g.* 75 dpi)

Medium resolution (*e.g.* 150 dpi)

High resolution (*e.g.* 300 dpi)

Default: HIGH

X Scaling

Y Scaling

(Only with Destin PRINTR/SPC)
Each printer has a specific resolution in dots/inch of the X and Y axes which, in conjunction with the screen resolution, may not always yield a suitable print format. To obtain a well-balanced ratio for the X and Y axes and to make optimum use of the available sheet area, some printers require scaling of the X and Y axes (preferably in integer multiples), as well as the assignment of a suitable print format (landscape or portrait).

Note: *When using non-integer multiples, pixels are suppressed or printed several times, which may degrade the quality of the hardcopy.*

The actual size of the printing format is shown in the lines Prn Width and Prn Height. For an orthomorphic projection, a width/height ratio of 640/435 = 1.47 must be set.

Specified range: 0.1 to 10 for X and Y axes

Orientatn

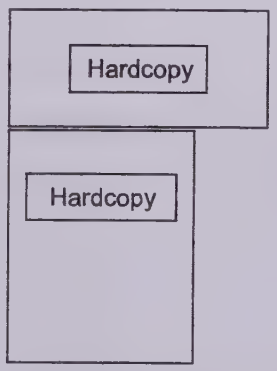
LANDSCAPE

PORTRAIT

(Only with Destin PRINTR/ SPC, PRINTR/PS, FILE/PS and FILE/EPS)

= Horizontal format

= Vertical format



Note: *PostScript printouts (up to 6 pictures/page) are automatically placed optimal with no regard to selected orientation; see Plots/Page below!*

Default: LANDSCAPE

Color

(Only with Destin PLOTTR/HPGL, FILE/HPGL, PRINTR/HPGL, PRINTR/PS, FILE/PS and FILE/EPS)

ON

Destin = FILE/HPGL:
Information is stored **in colours** in the file referred to as "Filename".

Destin = PLOTTR/HPGL, PRINTR/HPGL:
Relation of colors to **color pens** see 2.14.2 Output in HP-GL Format

Destin = PRINTR/PS, FILE/PS and FILE/EPS
Information, which scan or which line will be painted in which color, in which line style and in which line width, is taken from file C:\UPL\REF\PS.CFG (see 2.14.4.1 PostScript Configuration File PS.CFG).

OFF

Destin = FILE/HPGL:
Information is stored in **black-and-white** mode in the file referred to as "Filename".

Destin = PLOTTR/HPGL, PRINTR/HPGL:
Only **one color pen** is used.

Destin = PRINTR/PS, FILE/PS and FILE/EPS:
Curves, bargraphs and linegraphs in gray shades. Information, which scan or which line will be painted in which **shades of gray**, in which line style and in which line width, is taken from file C:\UPL\REF\PS.CFG (see 2.14.4.1 PostScript Configuration File PS.CFG).

Default: OFF

Filename

(with destinations FILE/PCX, FILE/HPGL, FILE/PS and FILE/EPSonly)
Filename under which the PCX, HPGL or PostScript information is stored.

Destin = FILE/PCX
A PCX file with the extension *.PCX is created under the specified file name.

Destin = FILE/HPGL
A HPGL file with the extension *.GL is created under the specified file name.

Destin = FILE /PS:
A PostScript file with the extension *.PS is created under the specified file name. This file can be sent in DOS (e.g. `copy TEST.PS PRN:`) to a PostScript printer.

Destin = FILE /EPS:
An Encapsulated PostScript-File with the extension *.EPS is created under the specified file name. It differs from a *.PS file only in the first and second line (printed in bold in the example below):

Example:
```
%!PS-Adobe-3.0 EPSF-3.0
%%BoundingBox: 45 205 559 733
```

The BoundingBox contains information about dimensions and position of the image in the PostScript default coordinate system in pixels (one pixel = 1/72 inch = 0.35 mm) and informs the program executing the image integration on the size and position of the plot.
Data **45 205 559 733** from the above example specify the X and Y coordinates of the bottom left-hand and top right-hand corner of the plot in the PostScript default coordinate system.

To avoid this name having to be entered in the OPTIONS panel every time a printout is triggered, the user is queried on storing a file under the name of an already existing file, whether

- this file should be overwritten as from now (without any further query),
- the file should **not** be stored (and therefore not overwritten),
  - a new file name should be generated by an automatic increment of the (end) number of the file name displayed in the OPTIONS panel.

Notes on automatic increment:

- If the name does **not** contain a number, **one** number is added (starting with 1).
- If the filename contains **at least one** number, the numbers are considered spacers and incremented as long as there is no filename overflow (new filename contains more characters than the original one).
- When the last possible number is exceeded, an error message is output.

Examples for automatic increment:

SCREEN.PCX → SCREEN**1**.PCX	...	SCREEN**9**.PCX
SC**1**BW.PCX → SC**2**BW.PCX	...	SC**9**BW.PCX
SC**06**COL.PCX → SC**07**COL.PCX	...	SC**99**COL.PCX

Plot on

(With Destin PLOTTR/HPGL, PRINTR/HPGL and PRINTR/PS only)
Select the interface for HP-GL output.

COM2

The printer is connected to the serial COM2 interface (RS-232). Data transmission parameters for transmitter (UPL) and receiver (printer) must be identical. The parameters are set in the UPL with the COM2 PARAMETER commands in the OPTIONS panel and on the printer normally by means of slide switches.

LPT1

Some plotters and most of all printers can also be operated using the (parallel) printer interface. This setting is required especially for laser printers with HP-GL interpreter or PostScript printer.

IEC BUS

Some plotters and printers offer an IEEE-Bus interface. The bus address of the plotter/printer is set with the subsequent menu line 'IEC Adr.'

Default: COM2

IEC Adr

(With Destin PLOTTR/HPGL or PRINTR/HPGL only, if 'Plot on = IEC Bus' is selected)

IEEE-Bus address of plotter or printer connected.

Prn Width

(Only with Destin PRINTR/SPC, display function only)
Width of the printing format in cm.

An orthomorphic projection of the printing format results when the width/height ratio is 640/435 = 1.47 (435 is the height of the printing format in pixels without the softkey row).

Prn Height

(With Destin PRINTR/SPC, display function only)
Height of the printing format in cm.

Paper Size

(With Destin = PRINTR/PS, FILE/PS or FILE/EPS only)
Paper format

A4

The UPL plots are optimally positioned for paper format A4 (21 cm * 29.6 cm) and made up of 600 * 845 pixels (one pixel = 1/72 inch = 0.35 mm) in the PostScript default coordinate system.

LETTER

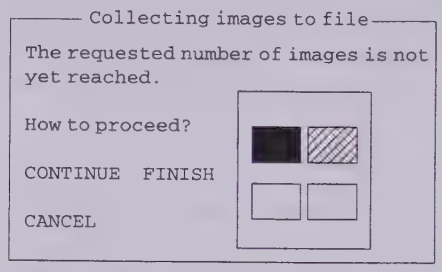
The UPL plots are optimally positioned for paper format LETTER (21.6 cm * 27.9 cm) and made up of 617 * 797 pixels.

Default: A4

Plots/Page

Number of UPL plots to be positioned on a PostScript page.

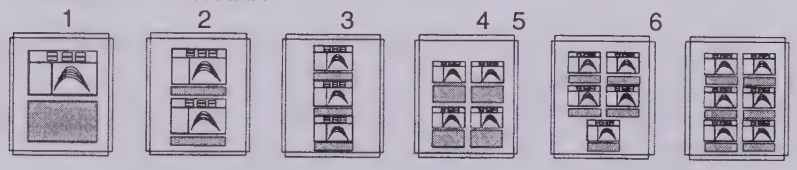
When two or more UPL plots (Plots/Page≥ 2) are printed on a page, the HCOPY key opens up a window where the page to be printed and the positions of the UPL plots are displayed:



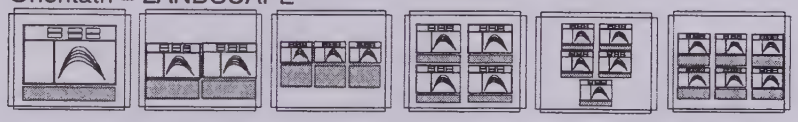
Filled-out box: the image has been already positioned
Hatched box: this image is being processed
Empty box: these images remain to be positioned

This window also allows the PostScript output to a printer or file to be aborted. Already positioned images are retained.

Automatic positioning, depending on paper orientation:
Orientatn = PORTRAIT



Orientatn = LANDSCAPE



Specified range: 1 to 6
Default: 1

HCOPY

(CTRL F8)

If Comment OFF is selected, pressing H COPY triggers a hardcopy without comments.

If Comment ON is selected, a dialog box opens after H COPY has been pressed. It is then possible to create a new comment for the printout, to edit an existing one or to actually trigger the hardcopy. In this box it can also be decided whether the hardcopy should be printed

- with or without comment
- with or without form feed.

Note: *With form feed suppressed, several screen copies may be printed on the same page.*

While a print procedure is in progress, pressing H COPY opens a dialog box where the printer output can be stopped or continued. A new screen copy can only be started after the previous one has been either terminated or aborted.

There are 4 kinds of outputs available; the user can determine the colour representation in different ways:

2.14.1 Screen Copy to Printer (pixel-oriented)

If dialog or selection boxes are active on the screen, their content is printed too. Thus particularly error messages or help texts can be printed.
Besides, an additional comment of max. 1500 characters can be entered via a dialog box and also printed out. This comment is also stored as additional file under the same name but with the extension ".CTX" when a COMPL SETUP is stored and loaded, too, when this setup is loaded. The comment file can be edited using a text editor.
Specify the type of device used for printout of the hard copy in the OPTIONS panel. Activate this panel by pressing the OPTIONS key or key combination ALT-O on the external keyboard.

If display of the cursors and their associated values in the display fields is not desired, the pointers can be switched off. Select OFF in the softkey menu under *-cursor and o-cursor.

Starting a screen copy:

Press the H COPY key (or CTRL-F8 on the external keyboard) if **no** printout is in progress. UPL requires a few seconds to prepare the screen copy and then continues with the measurements while printing is taking place in the background.

Different dialog boxes may be displayed when the hardcopy key is pressed:

- "Printer not ready" (error message):
  The connected printer is not switched on, it is OFF-LINE or the printer is not connected at all. After eliminating the fault, hardcopy can be restarted.

- "Hardcopy already in progress!":
  A screen copy is being made. Prior to starting a hardcopy the previous procedure must be terminated or interrupted.

- "Hardcopy / Comment".
  A comment or form feed can be added to the screen copy. If this is not desired, the dialog box can be blanked by selecting "Comment OFF" in the OPTIONS panel.

Speeding up a screen copy:

A hardcopy is in progress in the background while the UPL continues with the measurements. Copying can be speeded up by stopping the result output or sweep with the STOP/CONT key.

The print command can be output via remote control using the HCOPy:WAIT command. In this case printing is performed in the foreground and the time required for printing only depends on the speed and the buffer size of the printer. The program is continued when the printing procedure is terminated. This mode is recommended when several copies are to be made in succession as in this case it can be ensured that a new copy is only started after the previous one has been completed.

Aborting a screen copy:

A stroke of the H COPY key during printing opens a dialog box with the aid of which the current copy procedure can be stopped. Printing is stopped while the dialog box is displayed on the screen.

- If the procedure is aborted **before** the actual printout is started, i.e. during its preparation, the printer output is not started.
- If the procedure is aborted while the printout is **in progress**, all characters sent to the printer before the stop will be printed. The printout of these characters, which are already in the printer buffer, can only be stopped at the printer itself, i.e. by switching the printer off.

Colour handling

Pixel-oriented data on printer via printer driver for ,e.g., a hard copy of screen
Colour printers use another colour system than the screen (additive colour system red, green, blue with screen in contrast to subtractive colour system, e.g., cyan, magenta, yellow and black with printers). Also, the print-out of a yellow curve on a black background on white paper leaves something to be desired. Therefore, the colours are converted and can be adapted to user requirements. The desired colour for each of the 16 possible colours is read from the file PRN_CL.PLT, which can be edited by the user.
The only way to utilize shades of gray for differentiation purposes on black and white printers is to leave out individual points. This process, which is called dithering, is controlled by the file PRN_BW.PLT. The file contains cells of 8 x 4 points for each "gray" pen and can also be changed by the user to meet his needs. The colour 10 (Trace B) is dithered only, if the printer resolution exceeds one printer point per screen pixel.
Both files described above are located in the directory \UPL\REF and contain a description of their contents in the form of comments.
The colour No. 2 is used for the background of the frames and is drawn light-gray on the screen. If the black inscription does not contrast enough with this background, the latter can be set to WHITE using the command FrameCol. The colour specified in the file is no longer used, as is the case with selection of FILE DEF.

2.14.2 Output in HP-GL Format { XE "HP-GL-Format" }

Vector-oriented outputs in HP-GL format are usually output to plotters (Destin = PLOTTR/HPGL), however some laser printers also support the HP-GL format (Destin = PRINTR/HPGL), e.g. for plotting measurement traces. The output data can be filed, too (Destin = FILE/HPGL).

The colours for screen output and the assignment of the plotter pens can be looked up in the table below:

Table 2-38 Colours of screen output and assignment of plotter pens

Function/ type	UPL-LCD	UPL colour monitor	Plotter pen	Recommended colour
Panel	black	black	1	black
Trace A	black	green	2	green
Trace B	grey	yellow	3	blue
Axes B	grey	yellow	3	blue
Scales	grey	red	4	light red (thin line)

Prior to output of the HPGL data and vectors an initialization sequence is transmitted to the drawing device at the selected interface or to the file. With plotters, this sequence may be the information about P1/P2 points (sheet or drawing size) or on the sheet format (portrait/ landscape). Printers usually require an initialization sequence to be able to interpret HPGL information. If Destin = PRINTR/HPGL is selected this sequence is loaded in a prologue file designated GL_PRO.LOG. There is also an epilogue sequence, which is designated GL_EPI.LOG. These files are stored in the UPL/REF directory and can be modified by the user as required. They contain, for each character to be sent, 1 to 3 (ASCII) characters followed by a blank. This sequence is interpreted as 1 byte in decimal notation. HPLJ3_P.LOG and HPLJ3_E.LOG are supplied as sample files for initialization and reset of Laserjet3 printer. All files referred to are included in the \UPL\REF directory.

2.14.3 Output in PCX Format { XE "PCX-Format" }

Outputs in PCX format to file for further processing in other programs (Destin = FILE/PCX)..

The PCX file format contains a palette information. In this version used by UPL it consists of 16 entries, which assign the 16 colour types one colour, each, by means of indicating the respective red, green and blue portions. With black/white printout (Color OFF), only 16 black/gray/white hues are assigned. These palettes are filed in the UPL\REF directories under the names PCX_BW.PLT and PCX_CO.PLT. They can be edited by the user if other colours are required. The files contain comments indicating which pen is used for which colour.
The colour No. 2 is used for the background of the frames and is drawn light-gray on the screen. If the black inscription does not contrast enough with this background, the latter can be set to WHITE using the command FrameCol. The colour specified in the file is no longer used, as is the case with selection of FILE DEF.

2.14.4 Output in PostScript Format { XE "PostScript-Format" }

Outputs in vector orientated PostScript format on a PostScript capable printer (Destin = PRINTR/PS) or on file for further processing (Destin = FILE/PS) or integration into other programs (Destin = FILE/EPS).

PostScript is a frequently used graphics format for use with high-quality terminals, e.g. laser printers. The PostScript format implies a complete programming language with commands permitting a high-quality graphics hardcopy to be made irrespective of the printer type, provided the printer is equipped with a PostScript option.

Upon a stoke of the HCOPY key, UPL generates a plot of the screen content or of parts thereof with the aid of suitable PostScript commands. These commands are sent to the PostScript printer either directly or via the LPT1 or COM2 interface, or they are stored in a file (*.PS) which may be processed by users familiar with PostScript and viewed on the screen of a PC with the aid of a *previewer*.
This procedure should be adopted in the development phase of the PostScript copy to save paper and toner.
An Encapsulated PostScript file (*.EPS) can also be created. This file allows the UPL plots to be integrated into another PostScript file, document or graphics representation (see section **2.14.4.2 Integrating and Output** of PostScript Files).

Frequently used previewers are **GhostScript**, **GhostView** and **GSview**. They are available as free-ware on the Internet under the address **http://www.cs.wisc.edu/~ghost/**.

Up to 6 different UPL plots including head line or comments can be stored in a PostScript file according to a fixed pattern, format A4 or LETTER, PORTRAIT or LANDSCAPE, colour or monochrome print and the desired screen section being selectable.

PostScript settings are done in the OPTIONS panel:

Information about traces and lines to be printed and colour/shade of gray, line pattern and line width to be used can be seen in the PostScript configuration file PS.CFG (see section **2.14.4.1 PostScript Configuration File** PS.CFG).

Overview of PostScript commands in the OPTIONS panel:

```
SCREEN HARD COPY ----
Destin      PRINTR/PS     Output of PostScript format to printer
            FILE /PS      Output of PostScript format to file (*.PS)
            FILE  /EPS    Output of Encapsulated PostScript format to file (*.EPS)
Color       ON | OFF
Copy        SCREEN        | CURVE/GRID | CURVE
Comment     ON            | OFF
Paper Size  A4            | LETTER
Orientatn   LANDSCAPE     | PORTRAIT
Plot on     COM2          | LPT1              For Destin  PRINTR/PS only
Plots/Page  1...6
Filename    A:\UPL.PS                       For Destin FILE /PS only
            A:\UPL.EPS                      For Destin FILE /EPS only
```

2.14.4 1 PostScript Configuration File PS.CFG

The PostScript configuration file C:\UPL\REF\PS.CFG is a text file which contains all information about colour, gray level, line width and line pattern for

- curves of TRACE A (Scan 1 to 17),
- curves of TRACE B (Scan 1 to 17),
- limit curves (upper, lower)
- Y grid (low, medium and high priority)
- X grid (low, medium and high priority)

With **logarithmic scales** the grid line priority

"high"	has the values ..., 0.1, 1, 10, ...,
"medium"	the values ..., 0.5, 5, 50, ... and
"low"	is used for all other lines.

With **linear scales** the assigned grid line priority depends on the start and end value of the scale and is therefore difficult to predict.

The file has to be edited with an ASCII editor in the DOS operating system.
Several comment lines in the header of file PS.CFG inform on permissible line patterns, colours, gray shades and line widths.

Example of a PostScript configuration file PS.CFG

```
# The following linestyle strings are available:
# ------ or _____, ------,  ......,  .-.-.-
#
# The following color strings are available:
# red, green, blue, yellow, magenta, cyan,
# black, gray9, gray8, gray7, gray6, gray5,
# gray4, gray3, gray2, gray1, white
#
# The following gray levels are available:
# 0.0 (black) ... 1.0 (white)
#
# The following width values are available:
# Values > 0.0
#
#
#          ----------- Line ---------
#          Style   Color   Gray Width
TRAC A
Scan1:     _____   red     0.1  1.0
Scan2:     ------  green   0.2  1.0
Scan3:     ......  blue    0.3  1.0
Scan4:     .-.-.-  cyan    0.4  1.0
Scan5:     ------  magenta 0.5  1.0

TRAC B
Scan1:     ------  green   0.1  1.0
Scan2:     ------  gray1   0.2  1.0
Scan3:     ......  gray2   0.3  1.0
Scan4:     .-.-.-  gray3   0.4  1.0
Scan5:     ------  gray4   0.5  1.0

LIMIT LINE
Upper:     ......  yellow  0.4  2.5
Lower:     ......  yellow  0.4  2.5

GRID Y
Priority low:     ......  blue    0.4  1.0
Priority medium:  ......  blue    0.4  1.0
Priority high:    .-.-.-  blue    0.4  1.0

GRID X
Priority low:     ......  red     0.4  1.0
Priority medium:  ......  red     0.4  1.0
Priority high:    ......  red     0.4  1.0

#          color       gray
#        r  g  b
BACKGROUND COLOR
Frame: 0.7 0.7 0.7    0.7
Plane: 1.0 1.0 1.0    1.0
```

The expressions printed in bold are keywords required by the UPL for the search of parameters under Style, Color, Gray and Width. The parameters must be in the same line as the keyword and separated by at least one blank. Only the lines required for creating the PostScript format must be available. Faulty or missing entries are recognized when the file is accessed and in this case an error message is output on the UPL screen.

The following can be selected:
Style: 4 line patterns
Color: 17 colours and shades of gray for a colour PostScript copy (`Color = ON`)
Gray: Any number of gray shades for a monochrome PostScript copy (`Color = OFF`)
Width: Any number of line widths

2.14.4 2 Integrating and Output of PostScript Files

Integrating PostScript files in word processing and design programs

The EPS files created by the UPL are particularly suitable for integrating PostScript files in word processing and design programs. Most of these programs cannot interpret the contents of an EPS file. As a rule they show a frame with or without diagonal lines, or a light-gray rectangular with the name of the EPS picture is displayed instead of the drawing. However, the EPS file is completely and correctly printed out.

To get an idea of the picture content in word processing or design programs, a coarsely rastered bit map can be inserted in the EPS file. The bit map can be evaluated and displayed by some user programs without interpretation of the EPS file.

For this purpose a bit map has to be inserted into the EPS file generated in the UPL. The picture in the EPS file is in the form of a hexdump. The free-ware program **GSview** mentioned before is particularly suitable in this case.

Example:

After the start of **GSview**, the name of the EPS file into which the bit map should be integrated is entered under **File - Open**. Under **Bearbeiten - EPS Vorschau einfügen** (Edit - Insert EPS preview) a selection of graphics formats for creating the bit map is displayed, e.g. **Windows Metafile.** Subsequently the name of the EPS file with bit map is specified.

An EPS file with a bit map thus generated can be integrated in Microsoft Word 6.0, for instance, where the bit map is displayed in the Word document.

Example:

After starting the Windows program **Microsoft Word 6.0,** a window is opened with **Einfügen - Grafik** (Insert - Graphics), where the **file type Encapsulated Postscript (*.EPS)** and the **file name** of the EPS file to be inserted are selected.

The bit map is now displayed in the document. With **File Print...** the PostScript picture (not the bit map) is printed with the highest possible resolution, provided the correct PostScript printer driver is installed (see "Printout of PostScript files").

The Windows graphics program **CorelDRAW 5.0** is able to directly interpret and display an EPS file of the UPL:

Example:

File - Import - Aufzulistender Dateityp (file type listed) **- PostScript (Interpreted) (*.eps, *.ps)**

Printing PostScript files:

If a PostScript printer is available, EPS files can be directly printed, e.g. with command "**copy SCREEN.EPS prn:**" in **DOS.** Under **Windows** a printout at this low level is not possible. Here it is advisable to integrate the EPS file as described in a word processing or design program, a graphics program or in GSview with subsequent printout.

For printing EPS files that have been integrated in a word processing or design program, or *.PS or *.EPS files loaded with GSview, an appropriate PostScript printer driver should be installed. **It is not sufficient** to just connect a PostScript printer; a suitable PostScript printer driver should also be available.

Without an adequate printer driver being installed, Windows does not know that a PostScript printer is available and only an empty frame or, if a bit map is integrated in the EPS file, a coarsely rastered bit map is printed.

*To obtain a true PostScript hardcopy, a Postscript printer driver is **indispensable**, e.g. printer driver* **"HP LaserJet 4/4M PostScript"** for **HP laser printer LaserJet 4 Plus.**
Only in this case the original EPS file will be printed with the highest possible resolution.

Installation of a new printer driver under Windows 3.11:
Main group - system control - printer - add printer

2.14.5 Output of Measurement Traces and Lists

The following menu item is available in the OPTIONS panel under the heading PRINT.

The measured values and other block data are output to printer as numbers (in ASCII code) using this key (immediately executed, the H COPY key need not be pressed).

Type	
	The first column contains the data selected in the following. The values which would be on the X-axis with Curve Plot, usually the swept values, are contained in the second column.
OFF	Function is off.
TRACE A **TRACE B**	Prints the measured values selected for TRACE A (or TRACE B) in the DISPLAY panel. Also, units (and reference values, if any) are taken over from the DISPLAY panel.
EQUALIZATN	Prints the values of the equalization table.
LIM REPORT	Prints only values exceeding the limits. Limit check must be activated.
DWELL VALUE	Prints the values for the sweep dwell time.
LIM UPPER	Prints the upper limit curve.
LIM LOWER	Prints the lower limit curve.
X AXIS	Prints the values of the X-axis only.
Z AXIS	Prints the values of the Z-axis only.
TRACE A + B	Prints both traces next to one another. The X-axis is output in the 3rd column.

2.15 Setting and Displaying Auxiliary Parameters (OPTIONS Panel)

Activate the OPTIONS panel by pressing the OPTIONS key (UPL front panel) or key combination ALT-O (external keyboard). The panel is displayed on the right side of the screen.

2.15.1 Selecting the Remote-Control Interface (IEC/IEEE Bus/COM2)

Remote via

Defining the interface for UPL remote control.
The selection only affects the talker/listener mode but not the controller mode (e.g. via Automatic Sequence Controller UPL-B10).

IEC BUS

Remote control via the built-in IEC/IEEE-bus interface.

COM2

Remote control via the serial COM2 interface. Interface parameters are defined further down in the COM2 PARAMETER menu.

Note: *UPL uses 2 serial interfaces (9-pin).*
COM1 is not used by the instrument software and available for user applications (e.g. mouse).
COM2 is generally reserved for the instrument software (remote control, plotter control). In the event that it is used for user-specific applications make sure that it is not defined as a remote-control or plotter interface by a device setting, not even for a brief period of time.

UPL IEC adr

Defining the IEC/IEEE-bus address for the UPL to an IEC/IEEE bus.

Displayed only when "Remote via IEC BUS" has been selected.
Application: see **2.17 Connecting External Devices**

Note: The IEC/IEEE-bus address set or selected on UPL start-up remains unchanged when a setup or a default setup is loaded.

Specified range 0 to 31
Default: 20

Unit : none

COM2 PARAMETER

Defining the parameters for the serial COM2 interface. The parameters set here apply to remote control and hardcopy printout on a plotter on which the COM2 interface is selected. The parameters determined here comply with those of the connected instrument (host computer or plotter).

The following parameters are standard setting for the COM2 interface of the UPL:
9600 baud, even parity, 7 data bits, 1 stop bit.
These standard parameters are set upon UPL switch-on when the BACKSPACE key is pressed (loading the DEFAULT setup), UPL -d is entered at the DOS level or after (re)installation of an UPL software.
The COM2 parameters set upon UPL start-up or selected by the user remain unchanged when a setup

or the default setup is loaded. Thus it can be ensured that interface parameters having to comply with those of the connected instrument are not inadvertently overwritten.

Note: *Interface parameters should not be changed via the COM2 remote control.*
COM1 parameters can only be changed with the DOS command MODE at the operating system level. This can be done:

- *by changing the AUTOEXEC.BAT file,*
- *after quitting the UPL with the aid of the SYSTEM key,*
- *after execution of the SHELL command in the automatic sequence controller (UPL-B10).*

Further information on **baud rate**, **parity**, **data bits** and **stop bits** can be obtained from the UPL online help or the DOS help at the operating system level with command HELP MODE under section "Configure Serial Port".

Baud Rate	Transmission rate in baud (bits/s)
2400 Baud **3600 Baud** **4800 Baud** **7200 Baud** **9600 Baud** **19200 Baud** **38400 Baud** **56000 Baud**	Default setting: 9600 baud
Parity	Parity check
NONE	Switching off the parity check
EVEN	Check for even parity (default setting)
ODD	Check for *odd* parity
Data Bits	Number of data bits
7 **8**	Default setting: 7
Stop Bits	Number of stop bits
1 **2**	Default setting: 1

Handshake	Type of synchronization
RTS/CTS	Handshake between UPL and controller via RTS and CTS lines (default setting). This is the simplest handshake procedure and probably the most used one in practical applications. The intelligence for a proper communication between controller and UPL is provided in the RS-232 interface ICs and the driver programs so that the user need not prepare a respective software. Suitable RS232 connection cable for RTS/CTS handshake between controller and UPL see 3.17 Remote Control via RS-232 Interface
XON/XOFF	Software handshake between UPL and controller. This procedures uses the control characters XON and XOFF (ASCII character DC1 = 11 hex and DC3 = 13 hex). If the UPL is temporarily unable to receive control commands or data (trace data), it sends the XOFF code. When ready again to receive, it sends the XON code. By providing an adequate software the user has to ensure that the controller does not send data when the UPL has signaled with XOFF that it is unable to process data. If the UPL sends data to the controller (measurement results, trace data, query responses) and the controller is temporarily unable to receive them, it sends XOFF. The UPL stops data transmission which is continued only after the controller has sent an XON. Suitable RS232 connection cable for XON/XOFF handshake between controller and UPL see 3.17 Remote Control via RS-232 Interface

2.15.2 Beeper On/Off

Beeper

ON A brief audible warning is output in the case of error messages, when specified ranges or limits are exceeded and at the end of sweeps.

OFF Beeper switched off.

2.15.3 Keyboard Settings

The settings refer to both the UPL front panel and the external keyboard (if available).

Rep rate

(Repetition rate)

Number of generated key codes per second (unit: Hz) with repetitive triggering.

Specified range: 0 (no repetitive triggering) to 50 Hz
Default: 10 Hz

Rep delay

(Repetition delay)

Time delay until repetitive triggering responds (Unit: s).

Specified range: 0.25 to 1.0 s
Default: 0.5 s

2.15.4 Language of Help Texts

Language

Selecting the language used for online help. Key functions of the external keyboard remain unchanged but they can be changed for instance via the auxiliary program BOOTSET.BAT.

Note: *The selected language is not changed when a setup or default setup is loaded.*

ENGLISH Help texts are displayed in English

GERMAN Help texts are displayed in German

The external keyboard functions are assigned with the aid of various AUTOEXEC.BAT files generated through copying with the auxiliary program BOOTSET.BAT.
For UK, AUTOEX_E.BAT and for GR, AUTOEX_D.BAT is copied to C:\AUTOEXEC.BAT. These files then call up the configuration file C:\UPL\USERKEYB.BAT where the standard keyboard assignment can be overwritten or further user-defined actions performed.

2.15.5 Display Settings

Extern disp (External Display)

INTERN ONLY Display on the built-in LCD screen only.

Note: *With model UPL-66 this menu item is ignored and COLOR set instead. Otherwise there would be a risk of (inadvertently) selecting (eg by loading a setup with this setting) and switching off the external monitor switched off. In this case UPL could only be operated "blind".*

BOTH COLOR Additional display on the external VGA monitor (see **2.17 Connecting External Devices**); use a colour monitor for colour output. The display has been optimized for colour display, thus leading to reduced contrast quality on the built-in LCD screen.

BOTH AUTO Additional display on the external VGA monitor (see **2.17 Connecting External Devices**); the display mode (colour or monochrome) is adapted to the built-in LCD screen. Since the display has been optimized for the built-in LCD, the contrast quality is not reduced.

BOTH BW Additional display on the external VGA monitor (see 2.17 Connecting External Devices), however only monochrome. The contrast quality on the built-in monochrome LCD screen is not reduced in this mode.

2.15.5.1 Switching the Measurement Display ON/OFF

Meas Disp (Measurement Display)

OFF Measured value and status displays are switched off. This increases the performance of the measurement routines. Sweeps are up to 15% faster. To be recommended for sweeps and FFTs if maximum performance is required. The status display reads the message

"MEAS DISPLAY OFF"
"Ctrl D to resume"

ON The measured value displays are switched on, measured value and status display are activated.

Note: *The MEAS DISP OFF/ON states can be switched via an external keyboard using the key combination Ctrl D.*

2.15.5.2 Reading Rate of Measurement Results

Read Rate

MAX SPEED	Maximum output speed of measurement results
6/S	6 measurement results / second
3/S	3 measurement results / second
1/S	1 measurement result / second

Note: *The setting is only effective in the measurement mode Continuous. With sweeps, start condition timechart and single triggered measurements, the measurement results are always output at maximum speed.*
The output speed over the IEC/IEEE bus is not influenced, and is always at a maximum.

2.15.5.3 Resolution of Measurement Results

Read Resol

CHOICE ...

A selection box appears after the SELECT key is pressed, in which the resolution of the measured value in trailing decimal places can be inputted for each measurement result window.
0: automatic display of the trailing decimal places
1 to 4: 1 to 4 trailing decimal places, whereby the result may be filled out with zeros

2.15.5.4 Graphics Display with Selectable Colours

When individual traces, trace groups (see section 2.9.3.3 Scan Count >1) and bars are displayed, a specific colour or shade of gray can be assigned to each trace or bar for easy distinction. Colour or shade of gray depends on the colour or monochrome representation selected under the menu item `Extrn Disp` (see section 2.15.5 Display Settings).
In addition a line pattern and line width can be assigned to sweep traces and trace groups.
Settings for colour/shade of gray, line pattern, line width are made in the OPTIONS panel under

DISPLAY
TRACES COLOR/LINE

The settings for colour and line pattern for max. 17 scans in channel A and channel B are stored in the self-explanatory text file C:\UPL\REF\TRCCOL.CFG.
In exceptional cases this file can be edited using an ASCII editor in the DOS operating system, on the condition that positions and length (correct number of trailing blanks) of the text are not changed.

Note: *If the file has been destroyed by mistake, it can be newly created using commands* `Scan conf = DEFAULT` *with a default setting.*
All scans of TRACE A are green, those of TRACE B yellow, uninterrupted, narrow lines.

The colour and line-pattern settings stored in this file are setup-independent and **remain unchanged when a setup or the default setup is loaded.**

Trace groups:
For trace group display (see 2.9.3.3 Scan Count >1) a colour/shade of gray and a line pattern can be assigned to max. 17 scans in channel A and channel B (DISPLAY panel: `Scan count ≥ 2)`.
If more than 17 scans are displayed on the UPL, the 18th scan is assigned the colour and line pattern of the 1st scan, etc.

Single sweep traces:
If only one sweep trace is displayed in channel 1 and channel 2
(DISPLAY panel: `Scan count = 1`), the colour/shade of gray and the line pattern specified under `Scannr.A = 1` and `Scannr.B = 1` will be assigned. Settings for `Scannr.A/B = 2...17` are meaningless.

Display of FFT, waveform and filter simulation:
ANALYZER panel:
FUNCTION = FFT I WAVEFORM I FILTER SIM
For displaying the traces in channel 1 and channel 2 for the above-mentioned measurement functions the colour/shade of gray specified under `Scannr.A = 1` and `Scannr.B = 1` is assigned. Assigning a line pattern is not useful and not performed.
Settings for `Scannr.A/B = 2...17` are meaningless.

Bargraph for DFD, THIRD OCT and MOD DIST measurement:
ANALYZER panel:
FUNCTION = DFD I THIRD OCT I MOD DIST
For a vertical bar display of channel 1 or channel 2 for these measurement functions, the colour/shade of gray specified under `Scannr.A = 1` and `Scannr.B = 1` is assigned. Assigning a line pattern is not useful and not performed.
Settings for `Scannr.A/B = 2...17` are meaningless.

Bargraph display:
The horizontal bars for BarA, BarB and BarX are displayed in the colour/shade of gray specified under `Scannr.A = 1.` If a limit violation occurs for one the bars (DISPLAY panel: LIMIT CHECK...) the colour/shade of gray changes as specified under `Scannr.B = 1` . Settings for `Scannr.A/B = 2...17` are meaningless.

PROTOCOL panel:
Parameters are displayed in the colour/shade of gray specified under `Scannr.A = 1,` comments are printed as specified under `Scannr.B = 1.` Variable parameters are always printed in red.

Result display:
The six measured values in the result display are represented in the colour/shade of gray specified under `Scannr.A = 1`, if no display of trace groups has been selected (DISPLAY panel: `Scan count ≥ 2).`

Scan conf

MANUAL

Colour/shade of gray and line pattern for each scan number entered with commands `Scannr.(A)` and `Scannr.(B)` can be separately changed.

DEFAULT

Automatic assignment of colour and line pattern to 17 scans of Trace A and Trace B. All scans of Trace A are green, those of Trace B yellow, continuous thin lines.

AUTO COLOR

Automatic assignment of colours to 17 scans of Trace A and Trace B, GREEN, YELLOW, BLUE, CYAN, MAGENTA and WHITE being assigned repeatedly in exactly this order. BLACK, DARK GRAY and LIGHT GRAY are assigned to the monochrome display.

Note: *If WHITE proves to be unfavourable for a scan because the limit lines are (normally) drawn in white, different colours can be assigned to these scans using the following commands.*

AUTO LINE

Automatic assignment of line patters to 17 scans of Trace A and Trace B, with the 4 thin line patterns ———— , `------`, `......` and `.-.-.-` being assigned repeatedly in this order.

Scannr.(A)
Scannr.(B)

Scan number 1 to 17, to which a colour/shade of gray or a line pattern is to be assigned using commands `Color(A/B)` and `Line(A/B)`.

If the **scan number 0** is entered, all 17 scans are assigned the same colour/shade of gray and the same line pattern, when command

`Color(A/B)`

or

`Line(A/B)`

is entered.

Specified range: 0 to 17
Default: 0

Color (A)
Color (B)

Assignment of colour/shade of gray to individual scans

GREEN
YELLOW
BLUE
CYAN
MAGENTA
WHITE

BLACK
DARK GRAY
LIGHT GRAY

Colour of scan number specified with command

```
Scannr.(A)
```

or

```
Scannr.(B),
```

if colour display is selected using command `Extrn Disp = BOTH COLOR`.

Shades of gray specified with command

```
Scannr.(A)
```

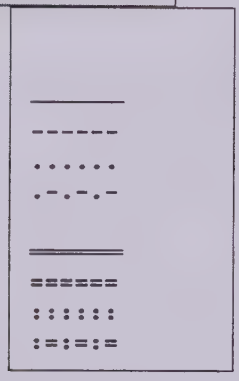
or

```
Scannr.(B),
```

if monochrome display is selected using command `Extrn Disp`

Note: *If colour/shade of gray is selected while* **`Scannr.(A/B) = 0`**, *all 17 scans will be assigned the same colour. To avoid this being done inadvertently, a query has to be confirmed before the command is executed.*

Line (A)
Line (B)



Line pattern for scan number specified with

```
Scannr.(A)
```

or

```
Scannr.(B).
```

Normal line width

Triple line width

Note: *If line pattern is selected while* **`Scannr.(A/B) = 0`**, *all 17 scans will be assigned the same pattern. To avoid this being done inadvertently, a query has to be confirmed before the command is executed.*

2.15.6 Calibration

Calibration ANL

Zero Auto

Dynamic offset calibration

OFF

DC offset calibration of the A/D converter or analog board is OFF; the most recently valid calibration factors are used.

Note: *Calibration should be switched off for short periods only (e.g. for the execution of a sweep), as otherwise large measurement errors may occur.*
*If autorange is used for the measurement, "Zero Auto ONCE" should be called up before calibration is switched off to make sure that **all** ranges which may be required are calibrated.*

ON

Cyclic calibration of the DC offset of the A/D converter or analog board for each voltage range separately.

Note: *A cyclic calibration is not performed while a sweep is running; it is delayed until the sweep is terminated or stopped.*

ONCE

Immediate offset calibration of the A/D converter or analog board for all ranges. Then the setting returns to the previously selected menu item.

Note: *Only the **currently** selected analyzer instrument is calibrated.*

Calibration GEN

Low Dist

Displayed only when the low-distortion generator is fitted.Permits automatic calibration of low-distortion generator.

OFF

Calibration of low-distortion generator inactive.

ONCE

Automatic calibration of low-distortion generator. Then the setting changes to OFF.
Allowed only after an operating time of at least one hour.

Calibration DIG

PhaseToRef

Displayed only with Jitter option UPL-B22 installed.
Permits automatic calibration of digital Phase To Ref measurement and generation.

OFF

Calibration of digital Phase To Ref measurement inactive.

ONCE

Automatic calibration of digital Phase To Ref measurement. Then the setting changes to OFF.

2.15.7 Version Display and Service Functions

The version numbers of software, analog and digital hardware and of options are displayed in the OPTIONS panel. Released software options are marked by INST (installed). As these menu items cannot be edited, they cannot be selected by the cursor.

VERSIONS

SOFTWARE ----------

Software	<version number>
Setup	<version number>
CPU board	<processor type>
Anlg board	<version number>
Dig. board	<version number>

OPTIONS ----------

B1 Low Dist	< version number >
B4 Rem Ctrl	INST/-NA-
B2 DigAudio	<version number>
U8 GSM DAI	<version number>
B5 Speaker	<version number>
B21 DA Prot	INST/-NA-
B22 DA Jitt	INST/-NA-
B10 SeqCtrl	INST/-NA-
B6 Coher	INST/-NA-
B33 ITU O33	INST/-NA-

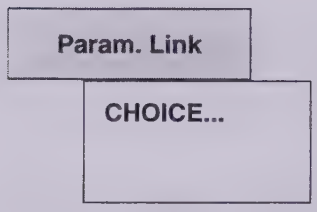
Any software, hardware or option which is not installed is marked by the letters -NA- (Not Available). Otherwise the version number is displayed for an installed hardware option or INST (installed) for a released software option.

Software options are released by entering the instrument-specific installation key under the menu item "InstallKey"; the installation key comes with a detailed description.

The service functions are also contained in the OPTIONS panel. They are given under menu item DIAGNOSTIC, protected by a password and not accessible to the user.

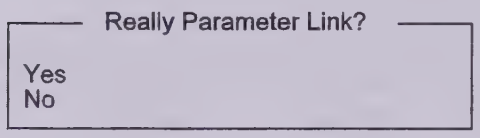
Only one of the options B2 and U8 can be installed at the same time.

2.15.8 Transfer of Parameters (Parameter Link Function)



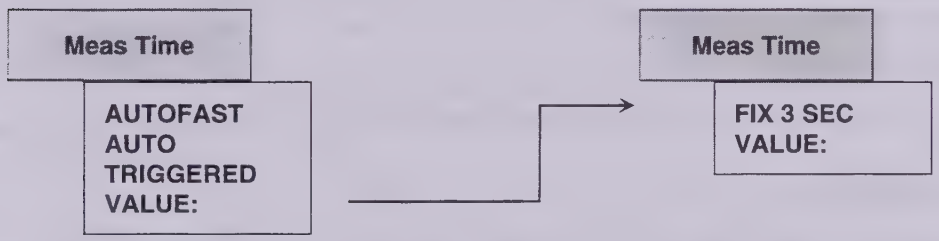
"Parameter Link" offers the possibility of transferring generator and analyzer settings to another signal or test function or to another instrument. The corresponding selection box is opened by pressing the SELECT key. The selected options are marked by a tick, see next page.

If a setting is made in UPL that enables the transfer of parameters in accordance with the options selected (marked with a tick), the user is prompted to confirm the transfer:



If YES is entered, the parameter setting is transferred to the new signal function when the signal function is changed. For the transfer, a corresponding command line must exist and the setting to be transferred must be selectable for the old and the new function.

Example:
Parameter Link with switchover from
RMS measurement function to DC measurement function



When switching from RMS to DC measurement mode, the setting VALUE: can be transferred. Transfer of the settings AUTO FAST, AUTO and TRIGGERED is not possible as these are not available for the DC measurement function.
Numerical values are transferred only if a corresponding command line exists and if the unit for a value in question is available for the new function or instrument. Transferring values from an analog to a digital instrument and vice versa is therefore not possible, nor is it useful. If the range of values of the new function or instrument is limited so that it does not allow transfer of the value despite appropriate unit, the value to be transferred is set to the upper or lower limit value of this range.

Explanation of menu items of parameter link box

Changing Gen Function keeps
FUNCTION parameters

When the signal function is changed, the settings of the old function are transferred to the new function.

Changing Gen Instrument keeps
Output Config.

When an instrument is changed, the configuration settings (those relating to the generator outputs) are transferred to the new instrument. No settings will be transferred for changeovers made between analog and digital instruments.

Changing Gen Instrument keeps
FUNCTION + Parameters

When an instrument is changed, the signal function and associated settings are transferred to the new instrument provided the signal function and settings are permissible for the new instrument.

Changing Anl Instrument keeps
FUNCTION parameters

When the measurement function is changed, the settings of the old function are transferred to the new function.

Changing Anl Instrument keeps
Input Config.

When an instrument is changed, the configuration settings (settings relating to the analyzer inputs) are transferred to the new instrument. No settings will be transferred for changeovers made between analog and digital instruments.

Changing Anl Instrument keeps
START COND

When an instrument is changed, the START COND settings are transferred to the new instrument.

Changing Anl Instrument keeps
INPUT DISP

When an instrument is changed, the INPUT DISP settings are transferred to the new instrument.

Changing Anl Instrument keeps
FREQ/PHASE

When an instrument is changed, the FREQ/PHASE settings are transferred to the new instrument provided that the function can be applied in the new instrument.

Changing Anl Instrument keeps
FUNCTION + Parameters

When an instrument is changed, the measurement functions and associated settings are transferred to the new instrument provided the measurement function and settings are permissible for the new instrument.

Function tracking Gen → Anl
MDIST, DFD, POL, FM → W&F

When the signal function of the generator is changed, the appropriate measurement function for the analyzer is set.

If any signal functions, measurement functions or configuration settings cannot be transferred, a warning will be output.

2.16 Macro-Operation

With the UPL, setting and measurement sequences can be written as BASIC programs or else recorded via the built-in program generator (see 3.16.4.3 Logging Mode - UPL-B10). Option UPL-B10 (Automatic Sequence Control) is required to do this. The generated BASIC programs can be stored (preferred file extension: .BAS) and called and used in various ways:

1. Call from BASIC user interface:

   Once the BASIC user interface has been activated by pressing F3 (on the external keyboard) or BACKSP (on the UPL keyboard), the program can be loaded with LOAD (softkey or F11) and then started with RUN (softkey or F6). The program name needs to be typed during loading. After the program has been quit, the UPL user interface is reactivated with F3 or the LOCAL key.

2. Automatic start of a BASIC program on switch-on:

   The UPL can be configured to load and execute (once) a particular program at switch-on. After the program has been quit, the UPL user interface is reactivated with F3 or the LOCAL key. The BASIC program can be either of the following:

   - the program INIT.BAS under C:\UPL\USER\, if the power-up mode has been set to 2 with the aid of utility programs BASSET or UPLSET.
   - any program whose name is entered with "-bn<filename>" as a call parameter when UPL is started.

3. Call from UPL user interface:

   Via the menu item "Exec Macro" on the OPTIONS panel, a BASIC file name can be selected with the aid of the standard file box. In the file box, all files with the extension .BAS are listed as standard. The selected BASIC program is loaded and started automatically. After the program has been quit, the UPL user interface is automatically reactivated.

   Advantages of this method:

   - All BAS files (macros) available in the selected directory are displayed in the file box.
   - Faster and more convenient file handling: the file can be selected directly from the UPL file box and does not need to be typed (possibly plus path) after activating the BASIC user interface.
   - As no file name needs to be typed, a macro of this type can also be started without an external keyboard (which is required for typing text into a BASIC user interface).

4. Call from an external control program via IEC/IEEE-bus interface:

   Any BASIC program can be loaded and started with the IEC/IEEE-bus command SYST:PROG:EXEC. After the program has been quit, a 1->0 transition is generated in the RUN bit (#14) of the operation register. This is communicated to the controller via SRQ or serial poll so that it can fetch the measurement results. Data exchange between the external control program and the BASIC program can be performed via the measurement-result displays and the measurement-result buffers.

   Advantages of this method:

   - Modular measurement tasks; the controller is not directly involved with *how* the measurement is executed in UPL.
   - Reduction of controller workload; once the macro has been started, the controller can handle other tasks.
   - The measurement algorithms implemented in the BASIC programs of UPL-B10 also be called with a single keystroke in manual mode (see above).

Exec Macro

The file bearing the name shown here is loaded and executed as a BASIC file. It is essential this file was generated with the Rohde&Schwarz BASIC, eg in the autocontrol option of either UPD or UPL (UPD-K1 or UPL-B10).

Recommended file extension: .BAS

If the file cannot be opened or if it contains invalid BASIC lines, a BASIC error message is issued.

For infor about entering file names, see 2.3.2.5

2.17 Connecting External Devices

Important:
It is recommended to use shielded cables for connection of external devices!
Otherwise spurious emissions may slightly increase, adversely affecting a very sensitive device under test.

All connectors below are located on the UPL rear panel (see 2.1.2 Rear-panel View).

IEC/IEEE bus

Option: UPL-B4 (IEC-625/IEEE-488 interface)
Applications:

- Remote control of UPL from a host computer; select the address in the OPTIONS panel: "UPL IECadr" (see 2.15.1 IEC/IEEE-bus Address).
- SCREEN HARD COPY on a plotter connected to the IEC/IEEE bus; settings in the OPTIONS panel: "Destin → PLOTTER", "Plot on → IEC BUS", "IEC-Adr" (see 2.14 Printing / Plotting / Storing the Screen Contents (OPTIONS Panel)).

For IEC/IEEE-bus operation, see 3 Remote Control

RS-232 (COM1, COM2)

2 serial interfaces

The serial interfaces COM1 ad COM2 have the following standard configuration:

transmission rate 9600 baud
even parity,
7 data bits,
1 stop bit,
none retry.

Use of COM1 (free for user-defined instruments):

- Connection of mouse or rollkey; permits alternative operation of panels and softkeys (see 1.1.7 Connecting a Mouse, 2.3 General Instructions for Use).

Use of COM COM2 (reserved for instrument software):

- Remote control of UPL from a host computer. For remote-control operation see **3 Remote Control**.
- SCREEN HARD COPY on a plotter connected to COM2; settings in the OPTIONS panel: "Destin → PLOTTER", "Plot on → COM2" (see 2.14.1 Screen copy to printer (pixel-oriented)).

The interfaces can be reconfigured
- at operating system level using the DOS command MODE (changing to DOS with the SYSTEM key),
- automatically on power up of the UPL by making an appropriate entry into the AUTOEXEC.BAT file,
- when using the Universal Sequence Controller UPL-B10.

SYNTAX

mode com*m* [:] [b[,b[,d[,s[,r]]]]]
mode com*m* [:] [**baud**=*b*] [**parity**=*p*] [**data**=*d*] [**stop**=*s*] [**retry**=*r*]

Parameter

com*m*

Denotes the number of the pin for asynchronous data transmissions (COM). Valid values for m are 1 or 2.
If one of the following five parameters is omitted, **mode** uses the last setting of the omitted parameter. If the short form of the syntax is used (without the words **baud =, parity =, data** etc.), the **mode** command identifies the parameters by their position. If no value is entered for a particular parameter, the comma preceding the next parameter must be entered.

baud=*b*

Denotes the first two positions of the transmission rate in bits per second. The following list contains the valid values for b and the corresponding transmission rates:

11	110 baud
15	150 baud
30	300 baud
60	600 baud
12	1200 baud
24	2400 baud
48	4800 baud
96	9600 baud

This parameter can be abbreviated by omitting **baud =** and entering a value for *b*.

parity =*p*

Determines how the parity bit is used by the system to check transmission errors. *p* may assume one of the following values: **n** (none), **e** (even) or **o** (odd). The standard value is **e**. This parameter can be abbreviated by simply omitting **parity =** and specifying a value *p*.

data =*d*

Denotes the number of data bits per character: Valid values for *d* are 7 or 8. The standard value is 7 data bits. This parameter can be abbreviated by simply omitting **data =** and specifying a value for *d*.

stop =*s*

Denotes the number of stop bits defining the end of a character: 1 or 2. If the transmission rate 110 has been set, 2 stop bits are used as standard. Otherwise, the standard value is 1. This parameter can be abbreviated by simply omitting **stop =** and entering a value for *s*.

retry =*r*

Determines what is to happen in the case of a time exceeded error if **mode** attempts to send an output to a serial printer. The option causes a part of **mode** to remain resident in the working memory. The following list contains the valid values for r and a short description of their meaning.

e	Output an error following a status check of a busy pin
b	Indicate "busy" following a status check of a busy pin
p	Try until the interface accepts the output.
r	Indicate "ready" following a status check of a busy pin
n	Do not try again (standard). **none** can also be indicated for this value.

This parameter can be abbreviated by omitting **retry** = and specifying a value for *r.*

Serial interface:
Typical connections to external device with 9-pin connector (PC) using the acknowledge signal lines.

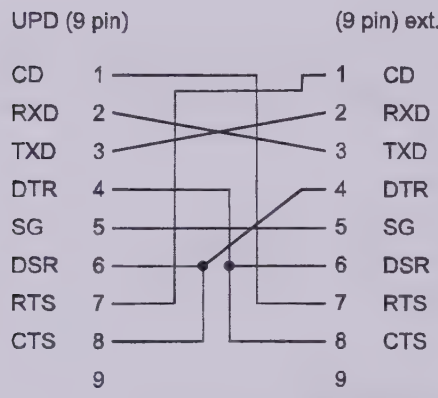


Fig. 2-44 9-pin serial interface

Typical connections to external device with 25-pin serial connector using the acknowledge signal lines.

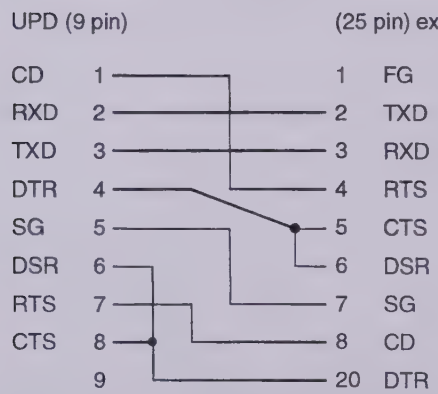
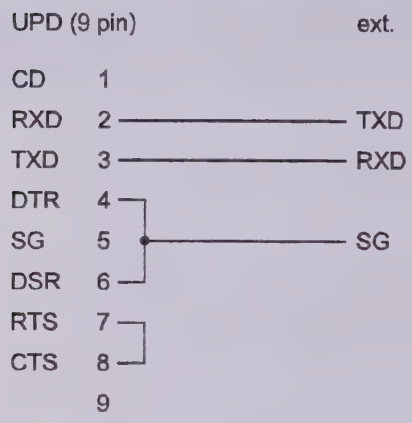


Fig. 2-45 25-pin serial interface

25-pin serial interface without acknowledge signal lines



FG: Frame Ground,
TXD: Transmitted Data,
RXD: Received Data,
RTS: Request to Send,
CTS: Clear to Send,
DSR: Data Set Ready,
SG: Signal Ground,
CD: Carrier Detect,
DTR: Data Terminal Ready.

Fig. 2-46 25-pin serial interface without acknowledge signal lines

Note: *The connection cable between UPL (9-pin connector) and the external device (e.g. plotter) should be configured as described in the instrument manual (of the plotter, for instance). The UPL side can be connected up as in the case of connection of an ISA (IBM-PC)-compatible computer.*

Centronics

Parallel interface for connection of a printer (see 2.14.5 Output of Measurement Traces and Lists)

VGA (external VGA monitor)

CRT interface for connection of a (colour or monochrome) VGA monitor
Advantages:

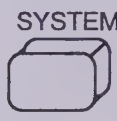
- Larger screen size
- Colour trace representation possible even for an UPL with monochrome screen

Switchover to the external monitor in the OPTIONS panel using the menu item "Extrn disp → BOTH..." (see 2.15.5 Display Settings)

Note: *When connecting an external monochrome VGA monitor, the file C:CONFIG.SYS must be changed (for more detailed explanation see comment in this file).*

2.18 UPL Used as Computer

The UPL software is created on the basis of the MS-DOS® operating system from Microsoft. MS-DOS commands and programs are available when exiting the UPL software. A user manual for MS-DOS is included in the accessories.



This key (or key combination CTRL-F9 on the external keyboard) is used to exit the UPL software. A dialog box is then displayed in which the command must be confirmed in order to avoid the inadvertent exit to the MS-DOS® operating system.

Note: *The key combinations CTRL-C or CTRL-PAUSE (via external keyboard only) have the same function as the SYSTEM key. Pressing these keys inadvertently therefore does not cause a program interruption.*

At the operating system level, the user is responsible for not changing or deleting the files required by the UPL. Also, the directory structure used should be maintained (see 1.3 Software Installation). The CONFIG.SYS and AUTOEXEC.BAT files required for starting the UPL should be modified by experienced users only.

The following three ways are possible for restarting the UPL software:

1. Call the UPL.BAT batch file by way of >UPL (where ">" is the input request by MS-DOS® and need not be entered).
2. Press the CTRL, ALT and DEL keys simultaneously in order to trigger a warm start.
3. Switch the UPL off and (after a few seconds) on again.

2.18.1 Setting the Realtime Clock

If the display of time or date is no longer correct in the UPL, the AT realtime clock must be set. This is effected at the operating system level using the DOS commands TIME and DATE. Exit from the current mode and access to the operating system is made using the SYSTEM key (cf.).

3 Remote Control

3.1 Introduction

- UPL may be equipped with option UPL-B4 permitting remote control via an IEC/IEEE-bus interface to IEC 625.1/IEEE 488.2 standard and an
- RS-232 interface at the COM2 port.

In addition, UPL may be equipped with option UPL-B10 permitting sequence control for automatic measurements.

Note:

The sections below mainly describe remote control via the IEC/IEEE-bus interface but most of them also applies to ***remote control via the RS-232 interface*** *and the* ***Universal Sequence Controller UL-B10.*** *If this is not the case reference will be made to the applicable section.*

Note:

If the remote-control option UPL-B4 was not originally ordered with the UPL, it may be obtained via the local sales engineer (for Order No. see data sheet). After entering an enable code as described in the supplied instructions, the IEC/IEEE-bus option and the RS-232 interface are ready for use without any additional hardware installations being required.

Note:

If the remote control option UPL-B4 is not enabled, UPL should not be connected to other instruments via the IEC/IEEE bus as in this case problem-free operation cannot be guaranteed.

The connectors for the IEC/IEEE-bus and the RS-232 interface (COM2) are located at the rear of the instrument. They allow a controller to be connected for remote control. The instrument supports SCPI version 1993.0 (Standard Commands for Programmable Instruments). The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and status registers (see section 3.5.1 SCPI Introduction).

Note:

In the IEC/IEEE-bus command lists given below, all commands confirmed or approved by the SCPI committee are written in normal characters.
Other innovative commands or commands required for general measurements are in italics and in the form and style as specified by SCPI (not part of SCPI definition).

This section assumes a basic knowledge of IEC/IEEE-bus programming and controller operation. A description of the interface commands is to be obtained from the relevant manuals.
The requirements of the SCPI standard placed on command syntax, error handling and configuration of status registers are explained in detail in the respective sections. Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers. For detailed program examples of the main functions see 3.15 Examples of IEC/IEEE-Bus Programming.

All program examples for IEC/IEEE-bus control are written in R&S BASIC, likewise all program examples in the UPL software in the paths

C:\UPL\IEC EXAM\EXAM1.BAS ff and
C:\UPL\B10 EXAM\EXAM1.BAS ff.

Examples C:\UPL\IEC EXAM\EXAM1.BAS ff can be directly run on a controller using a suitable IEC/IEEE-bus card and R&S BASIC. Files with the extension .SAC are setup files required by the program examples for setting the UPL. Files with the extension .TXT provide the program code of the examples as an ASCII file and can be accessed by any editor.

Note:

R&S BASIC and the R&S IEC/IEEE-Bus Interface/Basic may be ordered from your local sales engineer under the designation: ***PAT-B1, Order No. 1007115002.***

Examples C:\UPL\B10 EXAM\EXAM1.BAS ff can be run on an UPL using the Universal Sequence Controller UPL-B10. Meaning of files with the extensions .SAC and .TXT as described above.

3.2 First Steps (Read-in of Measured Values)

The short and simple operating sequence below permits rapid setup of the instrument and of its basic functions.
A condition is, however, that the **IEC/IEEE-bus address**, which is factory-set to **20**, **is not changed**.

Program example:
Triggering 10 measurement results and display on the screen.

1. Interconnect instrument and controller using the IEC/IEEE-bus cable.

2. Write the following program on the controller and start it with RUN (F2):

```
10 IEC TERM 10: '      Controller expects LF as a delimiter of an UPL reply
20 IEC TIME 5000:       'Controller waits max. 5 s for a reply from
30 '                            UPL before sending an IEC/IEEE-bus timeout
40 IEC OUT 20,"*RST": '                                   UPL default setup
45 IEC OUT 20,"INP:TYPE GEN2": ' Internal connection to generator channel 2
50 IEC OUT 20,"*CLS": '                 Resets IEC/IEEE-bus status register
60 FOR I = 1 TO 10
70 IEC OUT 20,"INIT:CONT OFF;*WAI": '        Triggers a single measurement
80 IEC OUT 20,"SENS:DATA?": '                Requests a measurement result
90 IEC IN 20, M$:                          ' Read-in of measurement result
100 PRINT M$:                               'Output of measurement result
110 NEXT I
120 END
```

As a result of the default setup with *RST (see annex **A UPL Default Setup** in the UPL manual), the UPL generator produces a 1-kHz sinewave signal with a level of 0.5 V.
Command `INP:TYPE GEN2` establishes an internal connection between generator channel 2 and analyzer channel 1 so that no cabling of outputs and inputs is required for this first test. The UPL analyzer carries out 10 RMS measurement, indicates the measurement results in the display and outputs them continuously on the controller display.

Note:

A measurement result must be triggered before it can be displayed on the screen (line 70). The settled result available after triggering can be requested (line 80), read-in (line 90) and output to the controller display (line 100).

3. Press the [LOCAL] key on the front panel to return to manual operation.

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.2 First Steps (Readout of Measurement Results)	See 3.17.4 First Steps (Readout of Measurement Results)

3.3 Switchover to Remote Control

After power-on, the instrument is always in the manual operating state (LOCAL state) and can be operated from the front panel or the keyboard. It is switched to remote control (REMOTE state) as soon as it receives an addressed command from a controller. During remote control, operation from the front panel is disabled. The instrument remains in the remote state until it is reset to manual operation via the front panel or the IEC/IEEE bus (see section 3.3.3 Return to Manual Operation). Switching from manual operation to remote control and vice versa has no effect on the instrument setup.

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.1 Connection Basic-UPL	3.17.2 Switchover to Remote Control

3.3.2 Setting the Device Address

The IEC/IEEE-bus address of the instrument is factory-set to 20. It can be changed manually under UPL IECadr in the OPTIONS panel or via the IEC/IEEE bus.

Manually: Enter the required address under **UPL IECadr** in the OPTIONS panel.

Via IEC/IEEE bus:

```
IECOUT 20,"SYST:COMM:GPIB:ADDR 30":'                    Set new address 30
HOLD 500:'          Wait approx. 500 ms before new commands are effected
```

Universal Sequence Controller (UPL-B10)	RS-232 interface
Not applicable	Not applicable

3.3.3 Indications During Remote Control

- The remote-control status is signalled by the word REMOTE in the display center and by the REM LED on the UPL front panel.
- Measurement results (active) are indicated in the upper part of the display.
- Error messages occurring during IEC/IEEE-bus control are displayed in plain text in the lower part of the UPL display (see also section 3.14 List of Error Messages).

3.3.4 Return to Manual Operation

Return to manual control can be made from the front panel or via the IEC/IEEE bus.

Manual:

- Press the [LOCAL] key, the REM LED goes out.

Note:

- *Prior to the switchover, command processing must be completed as otherwise remote control is immediately switched on again.*
- *The [LOCAL] key can be locked by the universal command LLO in order to prevent inadvertent switchover. In this case, switchover to manual mode is only possible via the IEC/IEEE bus.*
- *The lock of the [LOCAL] key can be cancelled by deactivating the "REN" line of the IEC/IEEE bus using the R&S BASIC commands IECNREN followed by IECREN.*

Via IEC/IEEE bus:

```
    :
IECLAD 20:'                Sets device to manual operation
IECGTL
   :
```

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.1 Connection Basic-UPL	3.17.3 Return to Manual Operation

3.4 IEC/IEEE-Bus Messages

The messages transmitted on the data lines of the IEC/IEEE bus can be subdivided into two groups:
- **interface messages** and
- **device-dependent messages**

3.4.1 Interface Messages

Interface messages are transmitted on the data lines of the IEC/IEEE bus, with the control line "ATN" being active. They are used for communication between the controller and the instrument and can only be sent by a controller with controller function on the IEC/IEEE bus.
There are two groups of interface messages:
- **common commands** and
- **addressed commands**

See 3.13.1, Universal Commands and 3.13.2, Addressed Commands

Common commands affect all devices connected to the IEC/IEEE bus without any addressing being required, whereas addressed commands only affect devices addressed as a listener. The relevant interface messages for the UPL are listed in annex A.

Universal Sequence Controller (UPL-B10)	RS-232 interface
Not applicable	Not applicable

3.4.2 Device-Dependent Messages (Commands and Responses)

The device-dependent messages are transmitted on the data lines of the IEC/IEEE bus, with the control line ATN being not active. The ASCII code is used for data transmission. Device-dependent messages are differentiated according to the direction in which they are sent via the IEC/IEEE bus:

- **Commands** are messages sent by the controller to the UPL. They control the device functions and request information.
  The commands are subdivided according to two criteria:
  1. According to the effect they have on the device:
     Setting commands cause device settings to be made, e.g. the resetting of the UPL or the setting of the output level to 1 Volt.

     Queries cause data to be provided for output via the IEC/IEEE bus, eg for device identification or query of the active input.

  2. According to their definition in the IEEE 488.2 standard:
     Common commands are precisely defined in their function and notation in the IEEE 488.2 standard. They refer to functions as for instance the management of the standardized status registers, resetting and selftest

     Device-specific commands refer to functions that depend on the device characteristics, such as frequency setting. A large number of these commands has also been standardized by the SCPI Consortium (see section 3.5.1 SCPI Introduction)

- **Responses** are messages sent by the UPL to the controller following a query. They may contain results, device settings or information on the device status (see section 3.5.4 Responses to Queries).

The section below describes structure and syntax of device-dependent messages. As from section 3.10 IEC-bus Commands onwards, the commands are listed independent of their function, described in brief and listed in alphabetical order.

3.5 Structure and Syntax of Device-Dependent Messages

3.5.1 SCPI Introduction

SCPI (Standard Commands for Programmable Instruments) describes a standardized command set for the programming of instruments regardless of the type of instrument or manufacturer. The goal of the SCPI Consortium is to standardize device-specific commands to a large extent. For this purpose an instrument model has been developed which defines identical functions within an instrument or of different instruments. Command systems have been generated and assigned to these functions so that it is possible to address identical functions by the same commands. The command systems have a hierarchical structure. Fig. 3-1 shows this tree structure, using a detail from the SOURce command system for controlling the signal sources of the instrument. The other examples of syntax and structure of the commands are taken from this command system.
SCPI is based on the IEEE 488.2 standard, ie it uses the same syntax elements as well as the "common commands" defined therein. The syntax of the responses is partly subjected to stricter rules than laid down in the IEEE 488.2 standard).

3.5.2 Command Structure

The commands consist of a so-called header and usually one or several parameters. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, eg space). The headers may be composed of several keywords. The query form is generated by appending a question mark directly to the header.

Common Commands

Common commands consist of a header preceded by an asterisk "*" and one or several parameters.

Examples

`"*RST"`	RESET, resets the UPL
`"*ESE 253"`	EVENT STATUS ENABLE, sets the bits of the Event Status Enable Registers
`"*ESR?"`	EVENT STATUS QUERY, queries the contents of the Event Status Register.

Universal Sequence Controller (UPL-B10)	RS-232 interface
Common commands to be used can be looked up in Table 3.9 Common Commands.	

Device-specific commands

Hierarchy

Device-specific commands have a hierarchical structure (see Fig. 3-1). The various levels are represented by compound headers. Headers of the highest level (root level) have one keyword only. This keyword stands fro a whole command system.

Example: `SENSe` This keyword denotes the command system SENSe (see section 3.5.7 Programming Model of UPL Generator)

For lower-level commands the full path has to be specified, starting with the highest level in the left-most position. The individual keywords are separated by a colon ":".

Example: "SENSe:FUNCtion:SETTling:MODE EXPonential"
(exponential settling of function test results)

This command is at the fourth level of the SENSe system. It selects the function settling mode.

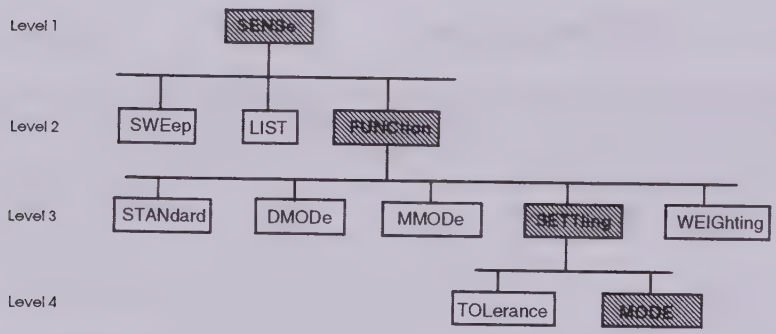


Fig. 3-1 Tree structure of SCPI command system, SENSe being shown as an example

Optional keywords: Some command systems permit certain keywords to be optionally inserted into the header or omitted. In the manual these keywords are marked by square brackets. For reasons of compatibility with the SCPI standard, the instrument must be able to recognize the full command length. Some of the commands become considerably shorter when the optional keywords are omitted.
Example: "DISPlay[:WINDow]:TEXT[:DATA] 'String'"
The following command has the same effect:
"DISPlay:TEXT 'String'" (text in graphic display)

Long and short form: The keywords have a long and a short form. The short form or the long form can be entered, other abbreviations are not permissible
Example: "STATus:QUEStionable:ENABle 1"
The following command has the same effect:
"STAT:QUES:ENAB 1" (0 bit of Status Questionable Register enabled)

Note:

The short form uses uppercase characters, the long form gives the whole keyword. Uppercase and lowercase letters are used for identification in the manual, the UPL itself does not differentiate between uppercase and lowercase characters.

Parameter: The parameter must be separated from the header by a "white space". If a command contains several parameters, they have to be separated by a comma ",". Some of the queries permit the parameters MINimum and MAXimum to be entered. For a description of the various types of parameter see section 3.5.5 Types of Parameters.
Example: "SENSe:FREQuency:STARt? **MAX**imum"
Response: 21641.8
(query requesting the maximum value for starting a frequency sweep)

Numeric suffix: If a device has several identical functions or features, eg inputs, the desired function can be selected by a suffix added to the command.
Example: "SENSe**2**:Voltage:REFerence 1V"
(reference value for a relative INPUT peak measurement

Note: *Entries without suffix are interpreted like entries with suffix 1*

3.5.3 Structure of a Command Line

All commands and data sent to the UPL are temporarily stored in a 1024-byte input buffer. Longer command lines can also be processed, the previously received part of the line being internally processed. A command line may take up more than one line on the controller display. The end of a line is determined by a delimiter.

Delimiters for a command set to the UPL:
A command line to the UPL may contain one or several commands. It is terminated by a <New Line> (ASCII code, 10 decimal) or <EOI> (EOI line active) together with the last useful character of the command line or by <New Line>. Since a <Carriage Return> character (ASCII code, 13 decimal) as a filler before the delimiter has no effect, the combination <Carriage Return><New Line> is permissible.

Example for generating the various delimiter combinations:

<Carriage Return>+<New Line>+<EOI> (default setting of IEC/IEEE-bus controller):

```
10 IECEOI
20 IECOUT 20,"XYZ"
```

If no ';' is sent at the line end, <CR><NL> is added.

<New Line>+<EOI>:

```
10 IECEOI
20 IECOUT 20,"XYZ"+CHR$(10);
```

';' ensures that no <CR><NL> is added.

<EOI>:

```
10 IECEOI
20 IECOUT 20,"XYZ";
```

';' ensures that no <CR><NL> is added.

<New Line>:

```
10 IECNEOI
20 IECOUT 20,"XYZ"+CHR$(10);
```

';' ensures that no <CR><NL> is added.

<Carriage Return>+<New Line>:

```
10 IECNEOI
20 IECOUT 20,"XYZ"
```

If no ';' is sent at the line end, <CR><NL> is added.

Universal Sequence Controller (UPL-B10)	RS-232 interface
User cannot influence the delimiter.	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus

Command string:

Several commands in a command line are separated by a semicolon ";". If the next command belongs to a different system, the semicolon is followed by a colon ":"

Example:

```
IECOUT 20,"SOUR:FREQ:STAR 20Hz;:SYST:BEEP:STAT ON"
```
(switches on beeper for error messages)

This command line contains two commands. The first command belongs to the SOURce system and is used to set the start frequency for a generator sweep. The second command is part of SYSTem and switches on an acoustic alarm in the case of errors.

If the successive commands belong to the same system and therefore have one or several common levels, the command line may be shortened. The second command following the semicolon then starts at the level that is below the common levels (see also Fig. 3-1). The colon after the semicolon has to be omitted.

Example:

```
IECOUT 20,"SOUR:FREQ:STAR 20Hz;:SYST:BEEP:STAT ON"
```
(Start- and stop command for sweep)

This command line is shown in full length and contains two commands separated by a semicolon. Both commands belong to the SOURce command system, FREQency subsystem, ie they have two common levels.
In the shortened command line the second command starts at the level below SOURce:FREQ. The colon after the semicolon has to be omitted.

The abbreviated form of the command line is:

```
IECOUT 20,"SOURce:FREQ:STAR;STOP 15kHz"
```

A new command line always begins with the complete path.

Example:
```
IECOUT 20,"SOUR:FREQ:START 20Hz"
IECOUT 20,"SOUR:FREQ:STOP 15 kHz
```
(Start- and stop command for sweep)

When common commands starting with an asterisk '*' are linked in a command string, they are preceded by a semicolon ';' and not by ';:' as is the case with linked UPL commands.

Example:
```
IECOUT 20,"INIT;*WAI;:SENS:DATA1?"
                  ↑
```
(triggers measurement, selects result of function measurement on channel 1 and sends next command only after completion of the measurement!)

3.5.4 Responses to Queries

Delimiters of responses sent by the UPL:

All responses sent by the UPL to the IEC/IEEE-bus controller are terminated by <New Line> (ASCII code, 10 decimal) and <EOI> (EOI line active). With the aid of the `IECTERM` command, the IEC/IEEE-bus controller can be set to various delimiters, but only the setting

`IECTERM 10` is useful.

- `IECTERM 10` causes the IEC/IEEE-bus controller to respond to the delimiter <New Line>. With
- `IECTERM 1` (EOI only)), the response string from the UPL displayed on the monitor of the IEC/IEEE-bus controller is followed by an empty line, as <New Line> before <EOI> is interpreted as part of the response string.
- `IECTERM 0` (<Carriage Return>+<New Line>), the response string from the UPL displayed on the monitor of the IEC/IEEE-bus controller will again be followed by an empty line, as the <Carriage Return> is interpreted as part of the response string and changed into a line feed command by the IEC/IEEE-bus controller.

All other settings cause a TIMEOUT.

Universal Sequence Controller (UPL-B10)	RS-232 interface
User cannot influence the delimiter.	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus

Possible queries

Unless explicitly specified otherwise, a query is defined for each setting command. The query is generated by appending a question mark to the associated setting command. Some of the SCPI rules imposed on the query responses are stricter than those of the IEEE 488.2 standard:

1. The requested parameter is sent without header.
   Example: **Setting:** `"INPut:TYPE BAL"`
   Query: `"INPut:TYPE?"` **Response:** `BAL`
   (input BAL for analog analyzer)

2. Maximum and minimum values requested by the character data MAXimum and MINimum are returned as numeric values
   Example: **Setting:** `"SENSe:FREQuency MAX|MIN|any value"`
   Query: `"SENSe:FREQuency? MAX"` **Response:** `21641.8`
   Query: `"SENSe:FREQuency? MIN"` **Response:** `2.0`
   (maximum or minimum value depend on current setting)

3. Numeric values with floating decimal point are output in the same unit as entered.
   Example: **Setting:** `"SENSe:FREQuency:STARt 20kHz?"`
   Query: `"SENSe:FREQuency:STARt?"` **Response:** 20.0 for 20 kHz
   (sweep start frequency)

4. Integral values are returned as such.
   Example: **Setting:** `"INST:NSEL 1"`
   Query: `"INST:NSEL?"` **Response:** `1`
   (25-kHz analog generator)

5. Text (character data) are returned in short form (see sections 3.5.1 and 3.5.4).
   Example: **Setting:** `"OUTPut:TYPE BALanced"`
   Query: `"OUTPut:TYPE?"` **Response:** `BAL`
   (generator output channel 1 XLR balanced)

6. Character strings are output in the same way as they are input, ie the simple and double quotation marks are also output (see section 3.5.6 Overview of Syntax Elements).

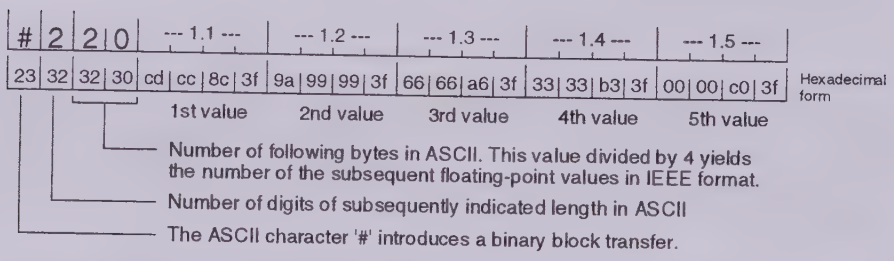
Example: **Setting:** `"MMEMory:STORe:STATe 2,'LASTSAVE.SCO'"`
Query: `"MMEMory:STORe:STATe? 2"` **Response:** `'LASTSAVE.SCO'`
(storage of UPL setting under 'LASTSAVE.SCO'

7. Data blocks are output as ASCII characters or in binary form depending on the IEC/IEEE-bus commands FORM ASC and FORM REAL.
Example:
Five floating-point values in the form of a trace are available after a sweep.

Setting: `"FORM ASC"`
Query: `"TRACe? TRACe"` **Response:** `1.1,1.2,1.3,1.4,1.5`
(load Y values of curve A into the UPL)

Setting: `"FORM REAL"`
Query: `"TRACe? TRACe"`

The **response** is sent as a binary data stream. Floating-point values are 4 bytes long and output in the IEEE format (LSB first):


#
2
2
0
--- 1.1 ---
--- 1.2 ---
--- 1.3 ---
--- 1.4 ---
--- 1.5 ---
23 32 32 30 cd cc 8c 3f 9a 99 99 3f 66 66 a6 3f 33 33 b3 3f 00 00 c0 3f
Hexadecimal form
1st value
2nd value
3rd value
4th value
5th value
Number of following bytes in ASCII. This value divided by 4 yields the number of the subsequent floating-point values in IEEE format.
Number of digits of subsequently indicated length in ASCII
The ASCII character '#' introduces a binary block transfer.

To receive the binary data stream in its full length, set **EOI** (in R&S-BASIC: **IEC TERM 1**) in the controller program and not LF (0Ah = 10d) (in R&S-BASIC: IEC TERM 10) as would normally be set for the reception of ASCII strings. This is to avoid the binary data stream being interrupted if the bit combination 0Ah occurs.

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.4 Differences from the IEC-bus Syntax - UPL-B10	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus

3.5.5 Types of Parameters

Most commands require the specification of a parameter. The parameters must be separated from the header by a "white space" (ASCII code, 0 to 9, 11 to 32 decimal, generally a blank). Parameters may be specified as numeric values, Boolean parameters, character data, character strings and block data. The type of parameter required for the specific command as well as the permitted range of values are described together with the commands (see section 3.10 IEC-bus Commands).

Numeric values

Numeric values may be entered in any customary form, ie with sign, decimal point and exponent. If the values exceed the resolution of the UPL, they will be rounded off. The number including the exponent may comprise up to 20 characters. The number of digits of mantissa and exponent is only limited by this condition. The exponent is denoted by an "E" or "e". The exponent alone must not be used. Physical quantities may be stated with the unit. Permissible prefixes for the unit (also called engineering) are M (Mega), K (Kilo), m (milli) and u (micro). The units for which these prefixes may be used can be seen from the tables in section 2.4 Units in the UPL manual. With no unit stated, the basic unit is assumed (see section 3.10 IEC-bus Commands column Basic unit of UPL manual).

Examples:

```
"SOURce:FREQuency 1.5 kHz"    1500 Hz
                  1.5E3       1.5E+3
                  1.5E 3      1.5E 03
                  +1.5E3      001.5E3
```

Special numeric values

The parameters MINimum, MAXimum, UP and DOWN are interpreted as special numeric values.

MIN/MAX

MINimum and MAXimum denote the minimum and maximum value.
Upon a query the numeric value will be returned.

Example: Setting command: `"SOURce:VOLTage MAXimum"`
Query: `"SOURce:VOLTage?"` **Response:** `24`
(maximum generator level)

UP/DOWN

UP increments, DOWN decrements the current numeric value by 0.001%.

NAN

Not **A** **N**umber represents the value 9,91E37, is only sent as a device response and denotes missing or illegal values.

Boolean parameter

Boolean parameters represent two states. The on state (true condition) is represented by ON, the off state (false condition) by OFF.

Example: Setting command: `"SENS:FUNC:WEIG ON"`
Query: `"SENS:FUNC:WEIG?"` **Response:** `ON`
(W&F weighting filter on)

Character data

Character data follow the syntax rules for keywords, ie they also have a short and a long form. Like any other parameter, they must be separated from the header by a 'white space'. A query returns the short form of the character data.

Example: Setting command: `"DISPlay:MODE COLB"`
Query: `"DISPlay:MODE?"` **Response:** `COLB`
(Coloured representation on internal and external display)

Character string According to SCPI strings must always be given in single or double quotation marks. Normally single quotes are used as the double quotes are used for identifying the total IEC/IEEE-bus command as a string.

Example: `"MMEMory:DELete 'C:\UPL\USER\MYSETUP.SCO'"`
(clearing of specified file)

Data strings Numeric values are to be separated by commas, decimal digits by a '.'.

Example: `"TRAC LIST1, 100.0,1000.0,5000.0,15000.0"`
(setting the X values in a graphics display)
`"SOUR:LIST:FREQ 1.1,1.2,1.3,1.4,1.5"`
(setting the frequencies for a frequency sweep)

Whether the data strings start with a comma or a blank depends on the command and is defined by SCPI.

3.5.6 Overview of Syntax Elements

The following list provides an overview of the syntax elements..

:	The colon separates the keywords of a command. In a command line, the colon following a semicolon identifies the highest command level.
;	The semicolon separates two commands in a command line. It does not change the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*	The asterisk identifies a common command.
"	Quotation marks denote the beginning of a character string and terminate it.
#	The double cross denotes the beginning of block data.
	A "white space" (ASCII code 0 to 9, 11 to 32 decimal, eg space) separates header and parameter.
.	Decimal point of numeric values.

3.5.7 Programming Model of UPL Generator

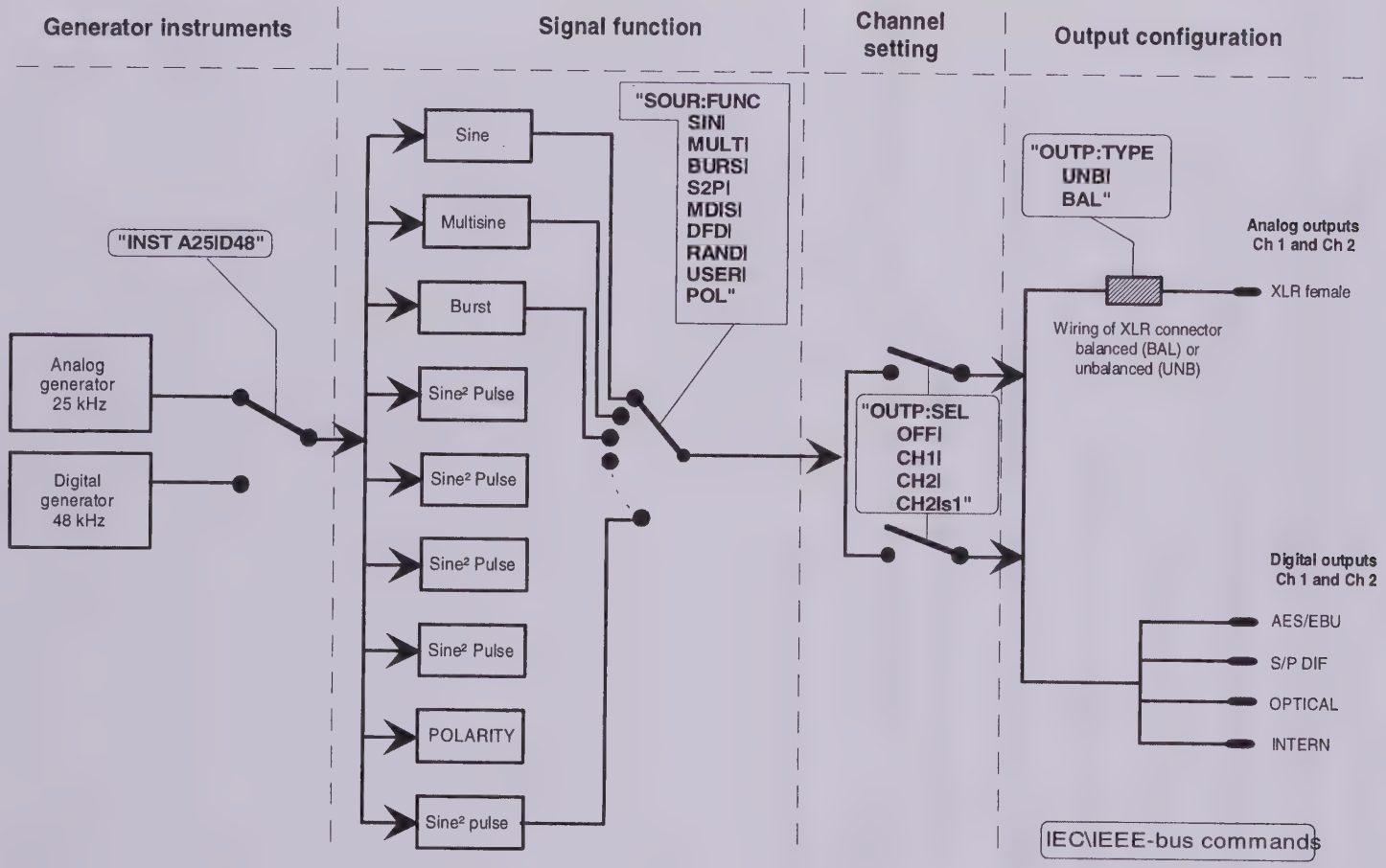


Fig. 3-2 Instruments and signal functions of UPL generator

3.5.8 Programming Model of UPL Analyzer

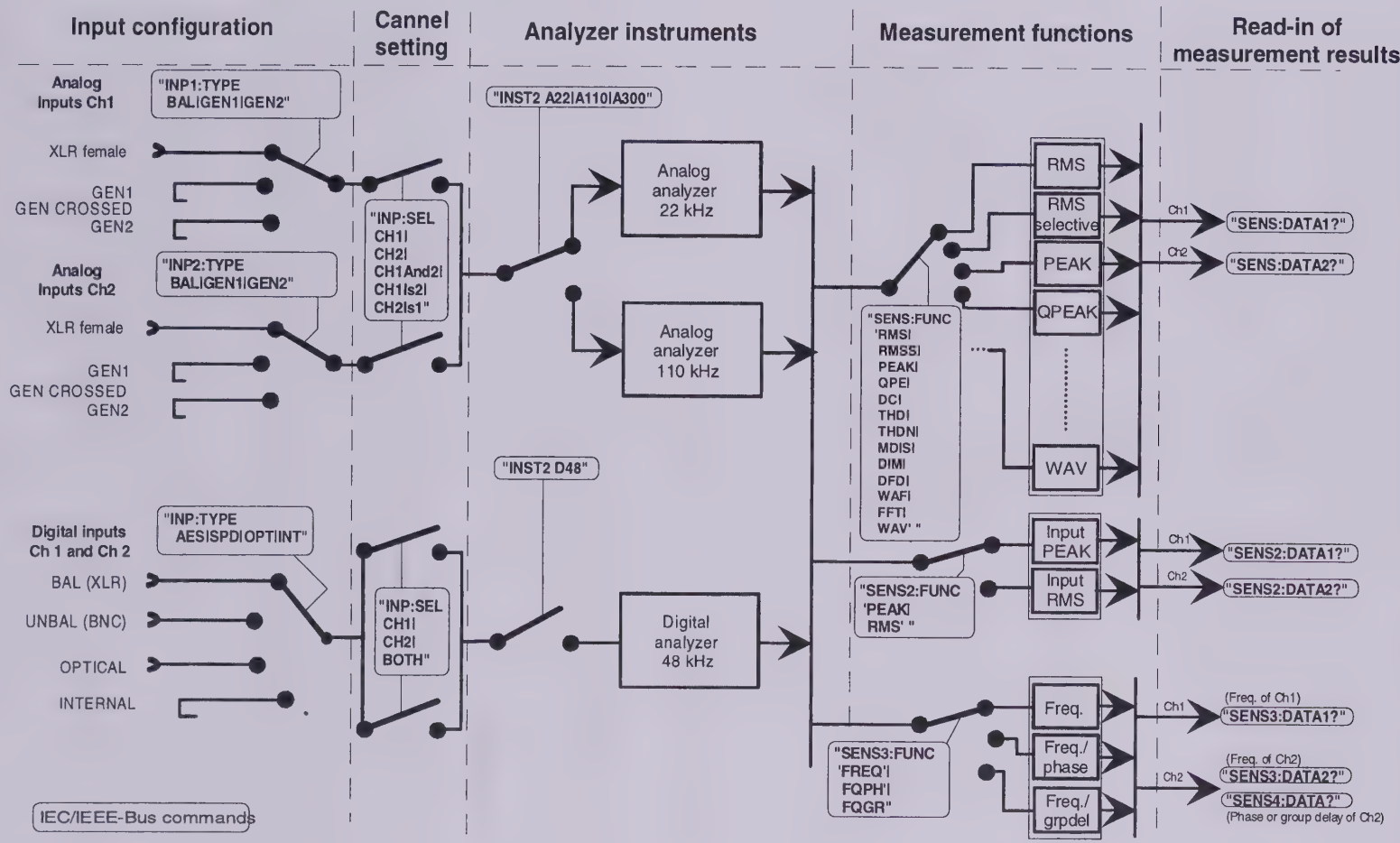


Fig. 3-3 Instruments and measurement functions of UPL analyzer

3.6 Instrument Model and Command Processing

The instrument model shown in the following figure has been configured under the aspect of processing IEC/IEEE-bus commands. The individual components operate independently of each other and simultaneously. They communicate with each other by means of so-called messages.

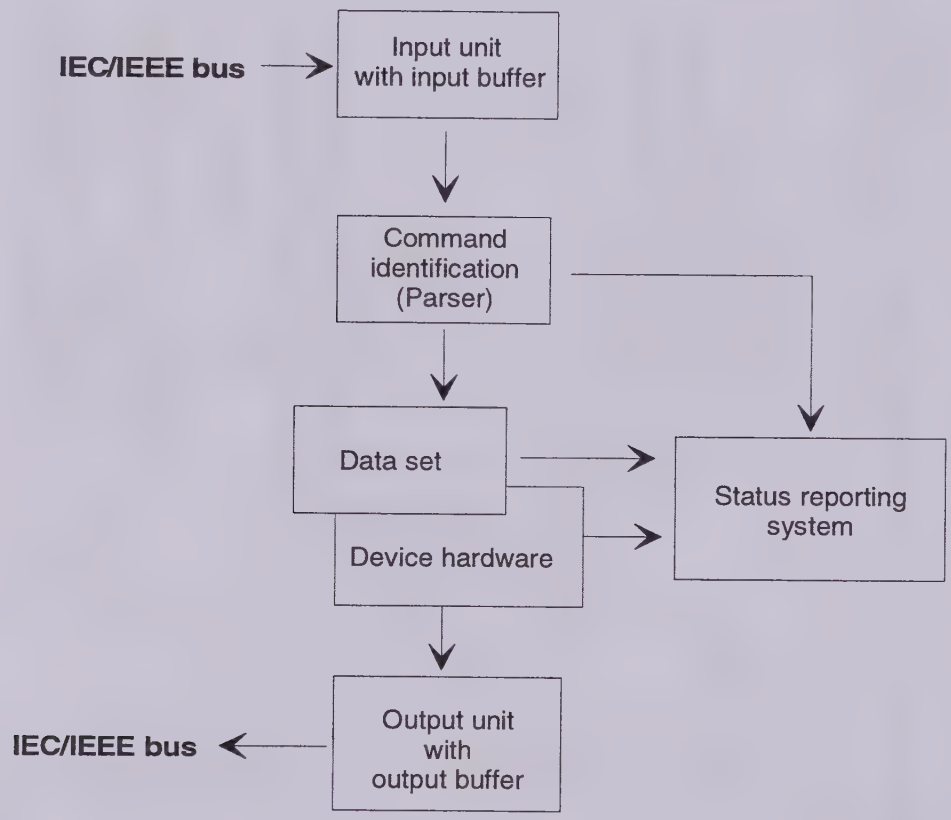


Fig. 3-4 Instrument model with remote control via IEC/IEEE-bus

3.6.1 Input Unit

The input unit receives the commands in the form of characters from the IEC/IEEE bus and collects them in the input buffer. The input buffer has a capacity of 1024 characters. As soon as the input buffer is full or receives the interface message DCL, transfer on the IEC/IEEE bus is stopped and the received data are sent to the parser where the commands are checked for syntax and semantic errors and the hardware is set in the sequence in which the commands arrived. Data transfer on the IEC/IEEE bus is then continued. However, if the buffer is not yet full when a terminator is received, the input unit can receive the next command while the previous command is identified and executed. Reception of a DCL clears the input buffer.

3.6.2 Parser

The parser (to parse = grammatically analyze) analyzes the data received from the input unit proceeding in the order in which the data are received. A GET (Group Execute Trigger), for example, is only processed when the previously received commands are executed. A DCL command will be given priority. Each command identified as correct will immediately be executed and causes a hardware setting.
Syntax and semantic errors are recognized and passed on to the status reporting system. The remaining part of a command line after the syntax error will be further analyzed as far as possible and processed.

While the parser is setting the hardware, the input unit can collect new commands in the input buffer. This means that further commands can already be processed while settings are being made in the hardware ("overlapping execution").

3.6.3 Setting the Device Hardware

The term "device hardware" refers to that part of the UPL which performs the instrument function proper: signal generation, measurements, etc. This does not include the controller.

An IEC/IEEE-bus command line which may contain several setting commands is sent to the parser, which checks the IEC/IEEE-bus commands for syntax and semantic errors. If a command is identified as correct, a check is made with the aid of the current settings whether the command is permissible. Permissible commands are taken over into the UPL data set (corresponds to hardware settings) and the device hardware is set. If it turns out that the command is illegal because of the existing settings, as for example a generator level of 20 V on the unbalanced outputs, an "execution error" message is sent to the status reporting system and no new settings will be made in the device hardware for this command. Subsequent commands which prove to be permissible are executed as described in the following section.
This strictly hierarchical sequence ensures that at no time illegal device states will be set.

3.6.4 Why is a Specific Operating Sequence Sometimes Required?

- Each IEC/IEEE-bus command received by the UPL is immediately checked whether it is permissible. This check can only be carried out if the UPL knows which instrument or function the command is intended for, ie if the addressed instrument or command has been activated **before.**

  Example1:
  Selecting an input impedance of 600 Ohm is permissible for the balanced input, not for the unbalanced one.

  If this check and the respective error messages were to be omitted, measurements would be carried out with incorrect instrument settings or would not be possible at all and the user would not even know about it.

  Example2:
  Setting: generator, unbalanced outputs.
  Remote programming of 20 V generator level.
  This is not possible, however, as the balanced output allows only 12 V to be set.

  - Should the UPL accept this incorrect setting without signalling an error because the user might afterwards select unbalanced outputs which can handle 20 V.
  - What will happen when this subsequent selection is not made?
  - Should the incorrect voltage be output?
  - Or, should an error message be output when the switchover is not performed?
  - And **when** should this error be signalled?

These conflicts can be avoided by observing the required operating sequence!

- Since similar menu items of different instruments or functions are addressed with the same command in remote control, they can only be distinguished by a reference to the currently used instrument or function.

  Example:
  Command `"INPut:SELect CH1"` may be used for all 3 analyzer units.

  To provide the possibility for presetting also parameters of non-active functions, information on the instrument or function to be addressed would have to be added to each IEC/IEEE-bus command. Thus the internal address management of UPL commands would have to be carried out by the IEC/IEEE-bus programmer. This would make programming unnecessarily difficult and the number of commands would increase by many times. The UPL uses approx. 6000 menu items which would then have to be "called up" separately by the user.

- An important operational feature of the UPL is its capability to note the settings for the individual generator and analyzer functions and to restore all required parameters when one of these functions is selected.

  This eliminates the need to reset each parameter when a new function is selected.

  Example:
  Settings: Generator, MOD DIST function with frequencies 400 Hz and 7 kHz.
  Switchover to DFD function
  The frequency pair 11 and 12 kHz, which was set when the DFD function was used last, is automatically reset.

  This function of the UPL is also available for operation via IEC/IEEE bus, ie even in the case of remote control a function switchover triggers an **automatic** reset of all pertaining parameters. This is a much quicker and more reliable than a reset of each parameter every time by the user via IEC/IEEE bus.
  If settings for non-active instruments would be permissible as well, this automatic function could no longer be used, as in this case already set parameters would also be overwritten.

- As the same internal data sets are used for manual and remote control (combined manual and remote control should be possible), the same method of internal parameter processing can only be allowed for the two modes. Since automatic parameter restoration is indispensable for manual control, it must also be used in the case of remote operation.

To relieve the user from having to pay attention to such not so obvious conditions, the following applies for manual and remote control of the UPL:

Any setting that is not permissible cannot become effective in the UPL

This has sometimes the disadvantage that a certain sequence has to be observed even in the case of remote-control. However, this is more than compensated for by the fact that setting errors are immediately signalled.

Note:

The command logging capability offered by the Universal Sequence Controller for UPL, option UPL-B10, minimized the risk of incorrect settings (see 3.15.3 Command Logging - Converting B10 into IEC/IEEE-Bus Commands*)*

3.6.5 Status Reporting System

The status reporting system collects information on the device status and makes it available to the output unit on request. Structure and function are described in detail in section 3.7 Status Reporting System.

3.6.6 Output Unit

The output unit collects the information requested by the controller. It processes such information in line with the SCPI rules and makes it available in the 1024-character output buffer. If the requested information is longer it will be made available in blocks in a way that is not noticeable to the controller.
If the UPL is addressed as a talker and the output buffer does not contain any data or expect data from the data set management, the output unit sends the error message "Query UNTERMINATED" to the status reporting system. No data will be sent on the IEC/IEEE bus and the controller waits for the set time limit. This procedure is prescribed by SCPI.

3.6.7 Triggering a Measurement/Sweep

A measurement or a sweep can be triggered in three different ways:

- With the SCPI-specific command `IEC OUT 20,"INIT"`
- With the Common Command `IEC OUT 20,"*TRG"`
- With the addressed command "Group Execute Trigger" `IEC LAD 20: IEC GET`

The three trigger modes take about the same execution time.

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.4 Differences from the IEC-bus Syntax - UPL-B10 The addressed GET command is illegal.	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus The addressed GET command is illegal.

Another three commands are available for waiting for a triggered measurement result. They are described in section 3.6.8.3 Comparison of Synchronization Capabilities. The synchronization command `"*WAI"` is used in the program examples below and in 3.15.15.1 Command Synchronization with *WAI for demonstrating the three trigger modes for a single measurement.

3.6.8 Command Synchronization

There are two events in the UPL, which have to be waited for before the next command can be executed to make sure that subsequent commands meet clear conditions:

- End of a calibration
- End of a measurement (measurement result ready to be fetched)

Through programming, the controller can be forced to wait for the end of a calibration or measurement (see table 3-2 Comparison of synchronization capabilities). Commands `"*OPC"`, `"*OPC?"` or `"*WAI"` are used to ensure that a calibration or measurement is completed before a new command is sent (see section 3.6.8.3 Comparison of Synchronization Capabilities).
In the examples below synchronization by means of the *WAI command is described.

3.6.8.1 Wait for End of Calibration

Wait for the calibration to be completed before sending the next setting command:

When analog analyzer instruments are called up with commands
```
IECOUT 20,"INSTrument2 A22;*WAI"
IECOUT 20,"INSTrument2 A110;*WAI"
```

with calibration switched on in the current setup ("CALibrate:ZERO:AUTO ON")
or upon loading a setup with commands

```
IECOUT 20,"MMEMory:LOAD:STATe 0, 'filename';*WAI"
          (current setup)
IECOUT 20,"MMEMory:LOAD:STATe 2, 'filename';*WAI"
          (complete setup)
IECOUT 20,"*RST;*WAI"
          (default setup)
```

with calibration switched on in the setup to be loaded ("CALibrate:ZERO:AUTO ON")
or after calling up a calibration with commands

```
IECOUT 20,"CALibrate:LDG:AUTO ONCE;*WAI"  or "CALibrate LDG;*WAI"
IECOUT 20,"CALibrate:ZERO:AUTO ON;*WAI"   or "CALibrate AUTO;*WAI"
IECOUT 20,"CALibrate:ZERO:AUTO ONCE;*WAI" or "CALibrate DCC;*WAI"
```

Without this forced synchronization, a subsequent generator or analyzer setting command would trigger a new calibration procedure.

3.6.8.2 Wait for End of Measurement/Sweep

Note:

In the explanations below the term measurement result denotes either a single measurement result or a sequence of results obtained in a single sweep.

A measurement or a sweep can be triggered by means of INIT , *TRG or GET (see section 3.6.8.2 Wait for End of Measurement/Sweep).
INIT will be used in the examples below.

With IEC/IEEE-bus commands assuming a settled measurement result, synchronization with *WAI, *OPC? or *OPC must be effected by means of an SRQ. The use of the three synchronization methods is described in section 3.6.8.3 Comparison of Synchronization Capabilities.
*WAI will be used in the examples below.

The effect of the various combinations of measurement or sweep trigger with a synchronization command is described in the table below.

Table 3-1 Trigger command with/without synchronization

Trigger command with/without synchronization	Description
"INIT:CONT OFF;*WAI"	A single measurement or sweep is triggered. Subsequent commands are processed after the measurement or sweep is completed. Generator and analyzer setting commands **do not** trigger a new measurement. A new measurement has to be triggered with IECOUT 20,"INIT;*WAI". **This command is the simplest to use and should preferably be used for triggering a measurement.**
"INIT:CONT OFF" **without** *WAI	When a generator or analyzer setting command is sent **during a single measurement**, ie before the measurement is completed, the measurement is restarted to avoid incorrect results (incorrect results could be obtained, for instance, when the generator voltage is varied during the measurement). Generator or analyzer setting commands sent **after the single measurement has been terminated** will **not** trigger a new measurement. A new measurement has to be triggered with IECOUT 20,"INIT".
"INIT:CONT ON;*WAI"	Generator and analyzer setting commands will only be processed when the measurement is terminated. They will **not** trigger a new measurements. A new measurement has to be triggered with IECOUT 20,"INIT;*WAI" .
"INIT:CONT ON" **without** *WAI	Each generator or analyzer setting command restarts a measurement to avoid incorrect measurement results (incorrect results could be obtained, for instance, when the generator voltage is varied during the measurement).

Note:

A synchronization of commands other than analyzer, generator, INIT, status loading or calibration commands is ineffective and should be avoided considering that synchronization commands are .

3.6.8.3 Comparison of Synchronization Capabilities

Table 3-2 Comparison of synchronization capabilities

Command	Action after hardware settling	Controller programming
*OPC?	Upon completion of the calibration or after a measurement result has been obtained, command "*OPC?" causes "1" to be entered in the output buffer. The "1" is irrelevant - the method is based on the fact that command IECIN 20,A$ stops the program run until the buffer has a "1". **This method is therefore not suitable to wait for a "1" in the program loop. This is possible with *OPC.**	IECOUT 20,"INST2 A22" IECOUT 20,"*OPC? IECIN 20,A$
*WAI	Upon completion of the calibration or after a measurement result has been obtained, the next command is executed.	IECOUT 20,"INST2 A22;*WAI"
*OPC	Upon completion of the calibration or after a measurement result has been obtained, the Operation Complete bit in the Event Status Register (ESR) is set which triggers an SRQ if bit 5 in the Status Enable Register is set.	- Set bit 0 in the ESE - Set bit 5 in the SRE - Wait for Service Request (SRQ) **Advantage over "*OPC?" and "*WAI":** While waiting for SRQ with the Operation Complete bit in the Event Status Register set, the program may carry out other tasks.

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.4 Differences from the IEC-bus Syntax - UPL-B10 *OPC cannot be used.	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus *OPC cannot be used.

Detailed examples for command synchronization are given in section 3.15.15 Command Synchronization

3.7 Status Reporting System

The status reporting system (see Fig. 3-6, Overview of Status Register) stores all information on the current operating status of the UPL, eg AUTORANGE being performed, and on errors. Such information is stored in the status registers and in the error queue. The contents of the status registers and of the error queue can be queried via the IEC/IEEE bus.

The information is hierarchically structured. The topmost level is formed by the Status Byte Register (STB) defined by IEEE 488.2 and the associated mask register Service Request Enable (SRE). The STB receives its information from the Standard Event Status Register (ESR) also defined in IEEE 488.2 and the associated mask register Standard Event Status Enable (ESE) as well as from the SCPI-defined STATus:OPERation and STATus:QUEStionable registers and the UPL-specific register STATus:XQUEstionable, which contain detailed information on the UPL.

The status reporting system also includes the IST flag (Individual STatus) and the Parallel Poll Enable Register (PPE) assigned to it. The IST flag, just as SRQ, combines the complete device status in a single bit. The PPE for the IST flag has an analog function like the SRE has for the Service Request.

3.7.1 Structure of SCPI Status Register

The STATus:OPERation Register and the STATus:QUEStionable Register (see section 3.7.3.4 STATus:OPERation Register and) consists of five registers of 16 bits each with different functions (See Fig. 3-5). The individual bits are independent of each other, ie each hardware status is assigned a bit number which is the same for all five registers. Bit 5 of the STATus OPERation Registers, for instance, is assigned in all five registers to the hardware status "wait for trigger". Bit 15 (the most significant bit) is set to zero in all registers. Thus the contents of the registers can be processed by the controller as a positive integer.

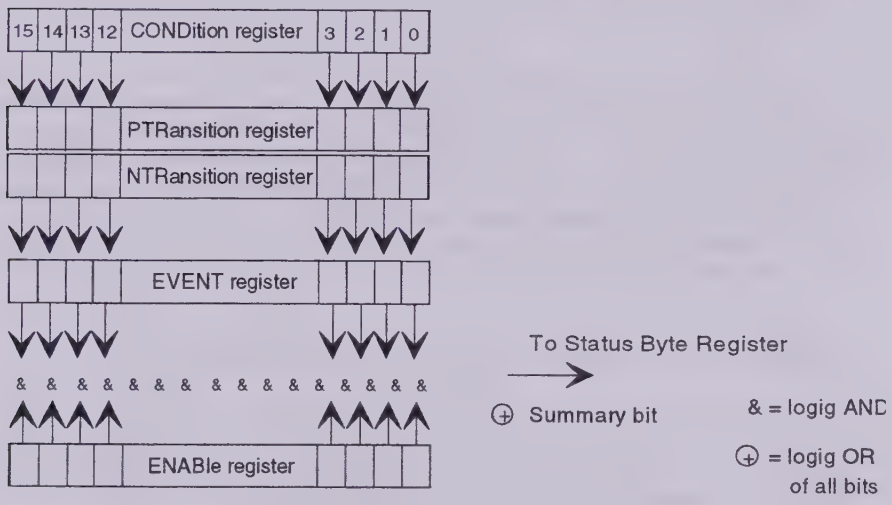

15 14 13 12 CONDition register 3 2 1 0
PTRansition register
NTRansition register
EVENT register
& & & & & & & & & & & & & &
ENABle register
To Status Byte Register
⊕ Summary bit
& = logig AND
⊕ = logig OR of all bits

Fig 3-5 Status register model

CONDition register The CONDition register is directly written to by the hardware or the summary bit of the next lower register. Its contents reflects the current device status. This register can only be read, but neither written to nor cleared. After an SRQ has been caused by an entry in one of the status registers, reading the CONDition register does **not** trigger another SRQ. Further SRQs are only possible when the EVENT register of the status register is read.

Reading the register does not change its contents.

PTRansition register The Positive TRansition register acts as a transition filter. Upon transition of a bit of the CONDition register from 0 to 1, the associated PTR bit decides whether the EVENt bit will be set to 1
PTR bit = 1: the EVENt bit is set.
PTR bit = 0: the EVENt bit is not set.
This register can be written and read.
Reading the register does not change its contents.

NTRansition register

The Negative TRansition register also acts as a transition filter. Upon transition of a bit of the CONDition register from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.
NTR bit = 1: the EVENt bit is set.
NTR bit = 0: the EVENt bit is not set.
This register can be written and read.
Reading the register does not change its contents.

With the aid of these two transition registers the user can define the status change of the CONDition register (none, 0 to 1, 1 to 0 or both) that is to be stored in the EVENt register.

EVENt register

The EVENt register reports whether an event has occurred since its last reading, it is the memory of the CONDition register. It registers events that have been reported by the transition registers. The EVENt register is continuously updated by the instrument. It can only be read by the user. **Reading this register clears its contents.** After an SRQ has been caused by an entry in a status register, another SRQ is only possible when the EVENt register of the status register is read. Reading the CONDition register does **not** cause another SRQ.

This register is frequently referred to as the overall register.

ENABle register

The ENABle register determines whether the EVENt bit affects the summary bit (see below). Each bit of the EVENt register is ANDed (symbol '&') with the associated ENABle bit. The events of all logical operations of this register are ORed (symbol '+') and passed on to the summary bit.
ENAB bit = 0: the associated EVENt bit does not affect the summary bit.
ENAB bit = 1: if the associated EVENt is "1", the summary bit is also set to "1".
This register can be written and read by the user.
Reading the register does not change its contents.

Summary bit

As stated above, the summary bit for each register is derived from the EVENt and the ENABle registers. The result is entered into a bit of the CONDition register of the next higher register.
The instrument automatically generates the summary bit for each register. An event, eg a non-locking PLL, may thus cause a service request through all hierarchical levels.

Note:

The Service Request Enable Register SRE defined in IEEE 488.2 may be considered as the ENABle register of the STB provided that the STB is configured in conformance with SCPI. Accordingly, the ESE may be considered as the ENABLe register of the ESR.

3.7.2 Overview of Status Register

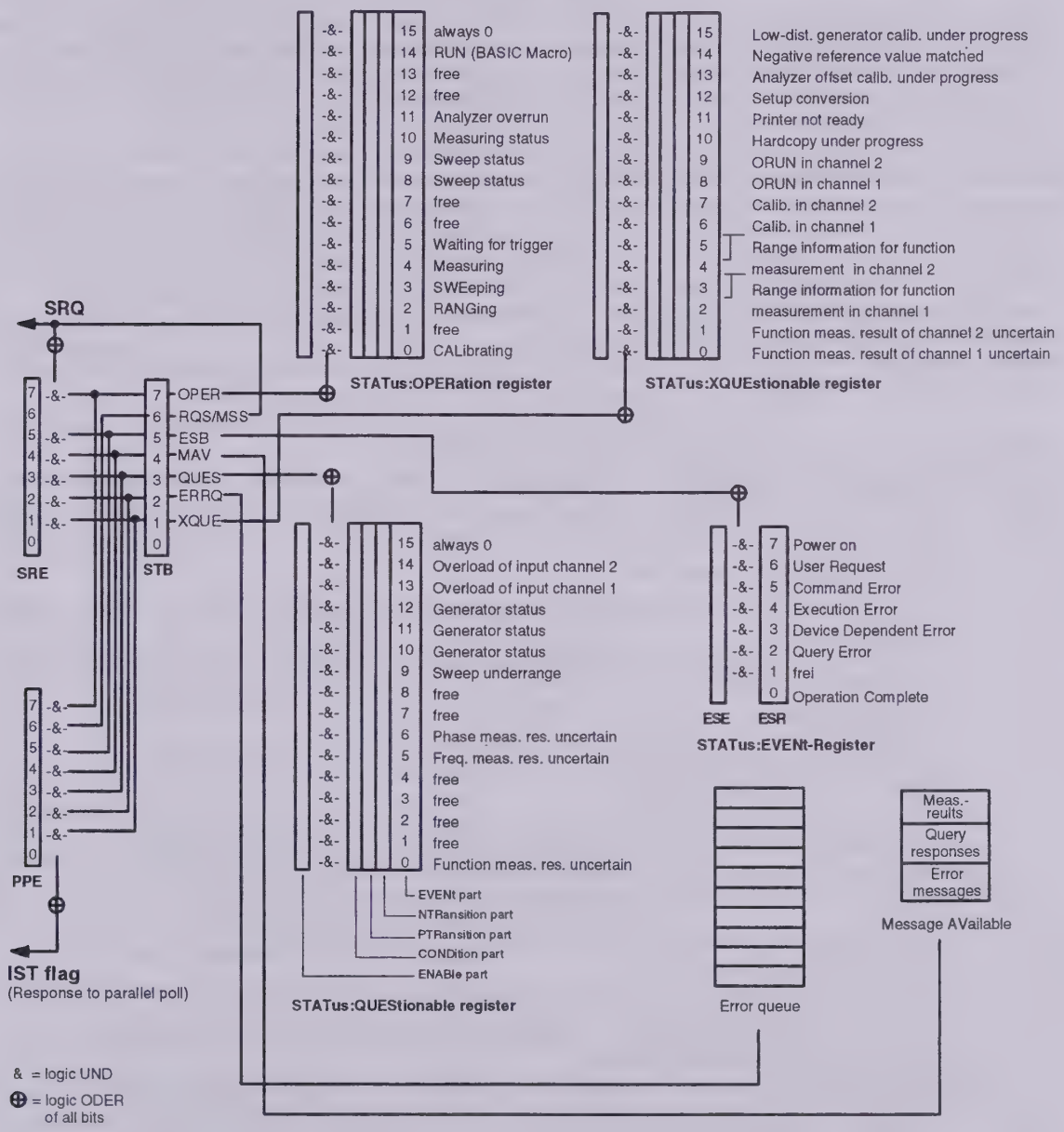


Fig. 3-6 Overview of Status Register

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.4 Differences from the IEC-bus Syntax - UPL-B10 List of usable commands of the status reporting system.	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus List of usable commands of the status reporting system.

3.7.3 Description of Status Registers

3.7.3.1 Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the UPL status, collecting information from the lower-level registers. It is comparable with the CONDition register of a SCPI-defined register and is at the highest level of the SCPI hierarchy. Its special feature is that bit 6 acts as the summary bit of all other bits of the Status Byte Register.
The Status Byte Register is read out by the query `*STB?` or a Serial Poll .

The SRE is associated with the STB. The function of the SRE corresponds to that of the ENABle register of the SCPI registers. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a Service Request (SRQ) will be generated on the IEC/IEEE bus, which triggers an interrupt in the controller configured for this purpose, and can be further processed by the controller.
The SRE can be set by the command `*SRE` and read out by the query `*SRE?`.
Its contents are <u>not</u> set to zero during reading.
If the EVENt part of a status register is read, the associated bit in the status byte register is deleted (eg STAT:OPER:EVEN? deletes the OPER bit (d7) in the OPERation register).

Table 3-3 Definition of bits used in the Status Byte Register

Bit No.	Definition
0	**Free**
1	**XQUEstionable Status summary bit** This bit is set if in the XQUEstionable Status Register an EVENt bit is set and the associated ENABle bit is set to 1. **The query command of the XQUEstionable Status Registers is "STATus:XQUEstionable:CONDition?" or "STATus:XQUEstionable[:**
2	**Error Queue** EVENt]?" The Error Queue contains an entry to be read with command "SYSTem:ERRor?" followed by IECIN.
3	**QUEStionable Status summary bit** This bit is set if in the QUEStionable Status Register an EVENt bit is set and the associated ENABle bit is set to 1. A set bit denotes a questionable device status which can be specified in greater detail by querying the QUEStionable Status Registers with "STATus:QUEStionable:CONDition?" or "STATus:QUEStionable[:EVENt]?"
4	**MAV** A measurement result, response to a query (IEC/IEEE-bus command with '?') or Error Queue entry is available and can be read with an IECIN command.
5	**ESB bit** Summary bit of the Event Status Register. This bit is set if one of the bits in the Event Status Register is set and enabled in the Event Status Enable Register. Setting of this bit denotes a serious error which can be specified in greater detail by querying the Event Status Registers with "*ESR?".
6	**MSS bit** (master status summary bit) This bit is set if the UPL triggers a service request. This is the case if one of the other bits of this register is set together with its mask bit in the Service Request Enable Register SRE.
7	**OPERation Status Register summary bit** This bit is set if an EVENt bit is set in the OPERation Status Register and the associated ENABle bit is set to 1. A set bit denotes that an action is just being performed by the UPL. Information on the type of the action can be obtained by querying the OPERation Status Register with "STATus:OPERation:CONDition?" or "STATus:OPERation[:EVENt]?".

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.4 Differences from the IEC-bus Syntax - UPL-B10	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus

Cannot be used	Cannot be used

3.7.3.2 IST Flag and Parallel Poll Enable Register (PPE)

Similar to the SRQ, the IST flag (**I**ndividual **St**atus Flag) combines the complete status information in a single bit. It can be queried by a parallel poll (see section 3.7.4.3 Parallel Poll, and 3.15.16.1 SRQ Interrupt Routine with Serial Poll or with "*IST?".

The Parallel Poll Enable Register (PPE) determines which bits of the STB affect the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE, bit 6 - in contrast to the SRE - being used too. The IST flag is obtained by ORing all results together. The PPE can be set by the command *PRE and read by the query *PRE?.

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.4 Differences from the IEC-bus Syntax - UPL-B10 Cannot be used	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus Cannot be used

3.7.3.3 Definition of bits used in the Event Status Register

The ESR is already defined in the IEEE 488.2 standard. It is comparable to the EVENt register of an SCPI register. The Event Status Register can be read out by the query *ESR?.
The ESE forms the associated ENABle register. It can be set by the command *ESE and read out by the query *ESE?.

Table 3-4 Definition of bits used in the Event Status Register

Bit No.	Definition
0	**Operation Complete** Upon reception of the "*OPC" command this bit is set exactly when all previous commands have been executed.
1	**Free**
2	**Query Error** This bit is set if the controller wants to read data from the instrument but has not sent a data request command, or if the controller does not fetch the requested data but sends instead a new command to the instrument. A frequent cause is a faulty query which cannot be executed.
3	**Device-dependent Error** This bit is set if a device-dependent error occurs. An error message with a positive number denoting the error in greater detail in plain text (see 3.14 List of Error Messages) will be entered into the Error Queue.
4	**Execution Error** This bit is set if the syntax of the command received is correct but the command cannot be executed due to various marginal conditions. An error message with a number between -200 and -300 describing the error in greater detail (see 3.14 List of Error Messages) will be entered into the Error Queue.
5	**Command Error** This bit is set if an undefined command or a command with incorrect syntax is received. An error message with a number between -100 and -200 describing the error in greater detail (see 3.14 List of Error Messages) will be entered into the Error Queue.
6	**User Request** This bit is set upon pressing the [LOCAL] key, ie when the instrument is switched to manual control.
7	**Power On** This bit is set upon power on of the instrument.

3.7.3.4 STATus:OPERation Register

The CONDition part of this register contains information on the operations currently performed by the UPL and the EVENt part on the operations performed by the UPL since the last readout of the register. The register can be read by the commands
`"STATus:OPERation:CONDition?"` or
`"STATus:OPERation[:EVENt]?"`.

Table 3-5 Definition of bits used in the STATus:OPERation register

Bit No.	Definition
0	**CALibrating** This bit is set as long as a calibration is performed by the UPL.
1	**Free**
2	**RANGing** This bit is set as long as the UPL performs a range change (eg. autorange).
3	**SWEeping** This bit is set while the UPL is performing a sweep. Bits 8 and 9 inform on the current sweep state.
4	**MEASuring** This bit is set while the UPL is performing a measurement. Bit 10 informs on the current measurement state.
5	**WAIT for TRIGGER** This bit is set while the UPL waits for a trigger event.
6 - 7	**Free**
8 and 9	**Sweep Status** Bit 3, 9, 8 0 0 0 = Sweep OFF — No sweep performed 0 0 1 = Sweep TERMINATED — Single sweep completed 0 1 0 = Sweep STOPPED — Sweep has been stopped and may be continued 0 1 1 = Sweep INVALID — Sweep invalid as not yet started 1 0 0 = Sweep MANU RUNNING — Manual sweep running 1 0 1 = Sweep SNGL RUNNING — Single sweep running 1 1 0 = Sweep CONT RUNNING — Continuous sweep running 1 1 1 = Sweep OFF
10	**Measuring Status** Bit 4, 10 0 0 = Measuring TERM — Single measurement completed 0 1 = Measuring STOP — Measurement stopped 1 0 = Measuring SNGL — Single measurement running 1 1 = Measuring CONT
11	**Analyzer Overrun** The sampling rate applied to the external input is too high for the digital meter selected. Remedy: - Select a lower external sampling rate and set function again - Select a fast digital meter.
12,13	**Free**
14	**RUN (BASIC-Macro)** If a BASIC macro (see **2.16 Macro Operation**) is started with the command SYST:PROG:EXEC 'filename.bas', this bit is set to 1. This bit is set to 0 when the program has been quit. This 1→0 transition can be queried via serial poll or initiate an SRQ, eg to fetch measurement data (for a detailed example see **3.15.18 BASIC-Macro aufrufen**
15	**Free**

3.7.3.5 STATus:QUEStionable Register

This register contains information on questionable device states. These may for instance occur if the UPL is operated out of specifications. The register can be read by the commands "STATus:QUEStionable:CONDition?" or "STATus:QUEStionable[:EVENt]?".

Table 3-6 Definition of bits used in the STATus:QUEStionable Register

Bit No.	Definition
0	**Function** This bit is set when the result of a function measurement is questionable.
1 - 4	**Free**
5	**FREQuency** This bit is set when the result of a frequency measurement is questionable.
6	**PHASe** This bit is set when the result of a phase measurement is questionable.
7 - 8	**Free**
9	**Sweep underrange** During the sweep, valid but inaccurate measurement results were obtained because of underranging.
10 - 12	**Generator status** Bit 12, 11, 10 0 0 0 = Generator OFF — Both generator channels are switched off 0 0 1 = Generator OFF 0 1 0 = Generator RUNNING — Generator outputs a signal 0 1 1 = Generator BUSY — Generator DSP computes a waveform 1 0 0 = Generator HALTED — No generator output signal due to incomplete or invalid setting 1 0 1 = Generator OVERRUN — The sampling rate applied to the external input is too high for the digital generator selected Remedy: - Select lower sampling rate, call up function again. - Select faster digital generator 1 1 0 = Generator OFF 1 1 1 = Generator OFF
13 -14	**Analyzer Status** Bit 14, 13 0 0 = — Normal working order (no overload at any channel) 0 1 = ANL 1: OVLD — Overload at input channel 1 1 0 = ANL 2: OVLD — Overload at input channel 2 1 1 = ANL 1: OVLD 2: OVLD — Overload at both input channels With input impedance of 300Ω or 600Ω one or both input channels are overloaded! To protect the analyzer input against damages the input impedance temporarily is switched to 200 kΩ and the generator output is turned off. Measurement will be continued. **Ways to recover from overload:** - remove overload (input voltage at 300Ω or 600Ω must not exceed 25 V) or - set input impedance to 200kΩ (INP:IMP R200K). Reactivate generator output by sending command "OUTPut ON". C.f. 2.13 Fast Switch-off of Outputs. The overload protection of the analyzer inputs is valid for analog board versions ≥ 4.00 and software version ≥ 1.0.
15	**Free**

3.7.3.6 STATus XQUEStionable Register

This register contains additional information for the Status Operation Register and information on rarely occurring states. It can be read by the queries "STATus:XQUEStionable :CONDition?" or "STATus:XQUEStionable[:EVENt]?".

Table 3-7 Definition of bits used in the STATus:XQUEstionable Register

Bit No.	Definition
0	Bit set: Information of MEASuring bit (d4) and Measuring Status bit (d10) of Status Operation Register refers to **channel 1**. MEASuring bit (d4) Measuring status bit (d10) 0 0 = Measuring TERM — Single measurement terminated on 0 1 = Measuring STOP — Measurement stopped on 1 0 = Measuring SNGL — Single measurement in progress on 1 1 = Measuring CONT — Continuous measurement in progress on
1	Bit set: Information of MEASuring bit (d4) and Measuring Status bit (d10) of Status Operation Register refers to **channel 2**. Analogous to bit No. 0.
2 - 3	Additional range information for **channel 1** d3 d2 0 0 = Measurement result valid 0 1 = Ranging in channel 1. Bit d2 (RANGing) of STATus OPERation Register set simultaneously. 1 0 = Underrange (measurement result inaccurate) in channel 1 1 1 = Overrange (measurement result invalid) in channel 1 Function bit d0 (function measurement result uncertain) of the Status Questionable Register set simultaneously with underrange and overrange bits.
4 - 5	Additional range information for **channel 2** d3 d2 0 0 = Measurement result valid 0 1 = Ranging in channel 2. Bit d2 (RANGing) of STATus OPERation Register set simultaneously. 1 0 = Underrange (measurement result inaccurate) in channel 2 1 1 = Overrange (measurement result invalid) in channel 2 Function bit d0 (function measurement result uncertain) of the Status Questionable Register set together with the underrange and overrange bits.
6	Bit set: The calibration denoted in bit 13 or 15 is in progress in **channel 1.** No measurements are performed during this period.
7	Bit set: The calibration denoted in bit 13 or 15 is in progress in **channel 2.** No measurements are performed during this period.
8	Bit set: The sampling rate at the external input of **channel 1** is too high for the digital instrument. Remedy: Set lower rate and recall measurement function.
9	Bit set: Ditto for **channel 2**
10	Bit set: Read-out of screen content to a printer or a file. Operation of UPL is disabled for a few seconds.
11	Bit set: Printer not ready.
12	Bit set: A previous SETUP is converted to the latest status.
13	Bit set: Calibration of analyzer offset in progress. No measurement results are output during this period.
14	Bit set: A negative reference value is limited to $+10^{-10}$ for the dBr calculation.
15	Bit set: Calibration of low-distortion generator in progress. No measurement results are output during this period.

3.7.4 Use of Status Reporting System

For an efficient use of the status reporting system, the information contained therein has to be transferred to the controller and further processed. There are various methods which are described in the following. Detailed program examples are given in 3.15 Examples of IEC/IEEE-Bus Programming.

3.7.4.1 Service Request, Use of Hierarchical Structure

Under certain conditions, the UPL may send a service request (SRQ) to the controller. This service request usually causes an interrupt at the controller to which the controller program can respond by a suitable action. As shown in Fig. 3-6 (Section 3.7.2 Overview of Status Register), a SRQ will always be triggered if one or several of the bits 3, 5 or 7 have been set in the Status Byte Register and enabled in the SRE. Each of these bits combines the information from a further status register. By setting the ENABle registers of the status registers accordingly, any bit in any status register will be able to trigger a SRQ. To utilize the possibilities of the service request, all bits in the enable registers SRE and ESE should be set to "1".

Examples:
(see also Fig 3-6 , Section 3.7.2 Overview of Status Register):

Use command `"*OPC"` for generating an SRQ. While waiting for the SRQ, the program may perform other tasks.

- Setting bit 0 (Operation Complete) in the ESE
- Setting bit 5 (ESB) in the SRE

Upon completion of the settings, the UPL generates an SRQ.

Indicating the end of a sweep by an SRQ via bit 3 in the STATus OPERation Register. While waiting for the SRQ the program may perform other tasks.

- Setting bit 7 (summary bit of STATus:OPERation Register) in the SRE
- Setting bit 3 (Sweep Terminated) in the STATus:OPERation:ENABle Register.
- Setting bit 3 in the STATus:OPERation:NTRansition to ensure that the transition of sweeping bit 3 from 1 to 0 (Sweep-Terminated) is also stored in the EVENt register. Calling up the *CLS command causes all bits of the NTRansition and PTRansition to be set to 1 so that any bit change is recorded. Enabling the desired enable bit, in this case bit 3, will normally be sufficient.

After having completed the sweep, the UPL generates an SRQ.

The SRQ is thus the only way for the UPL to become active of its own. A controller program should set the UPL so that a service request will be generated in case of malfunctions. The program should suitably respond to the service request. A detailed example of a service request routine is given in section 3.15.15 Command Synchronization.

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.4 Differences from the IEC-bus Syntax - UPL-B10 Cannot be used	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus Cannot be used

3.7.4.2 Serial Poll

Serial Poll is mainly used for obtaining a quick overview of the status of several devices connected to the IEC/IEEE bus
In the case of a Serial Poll, the status byte of a device can be queried with

```
IECOUT 20,"*STB?"
IEC IN 20,A%
```

However, querying the status byte is normally implemented by interface messages (see annex A, Interface Messages) which means that a single byte is set to the hardware.

The R&S BASIC command for the execution of a Serial Poll is

```
IEC SPL 20,A%
```

It is much quicker than the Common Command "*STB?".

The serial poll method has already been defined in the IEEE 488.1 standard and used to be the only standard method for querying the status byte of several devices. This method also works with instruments which neither conform to SCPI nor to IEEE 488.2.

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.4 Differences from the IEC-bus Syntax - UPL-B10 Cannot be used	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus Cannot be used

3.7.4.3 Parallel Poll

In the parallel poll mode up to eight devices are simultaneously requested by a command from the controller to transmit 1 bit of information on the assigned data line, ie to pull the assigned data line to logic 0 or 1. Similar to the SRE register which defines the conditions under which an SRQ will be generated, there is a Parallel Poll Enable Register (PPE), which is also ANDed bit by bit with the STB – taking into account bit 6. The result is ORed and is then returned (may be inverted) as a reply to a parallel poll of the controller. The result can also be read out without parallel poll by the query `*IST`.

The UPL must first be set for the parallel poll using the R&S BASIC command `IEC PCON`.
Example:

`IECPCON 20,1,6:` UPL identifies itself by a 1 on line 6.

This command assigns a data line to the device on which it sends an SRQ. The parallel poll itself is made by `IEC PPL Pp%`.
The parallel poll mode is mainly used to find out quickly which of the devices connected to the IEC/IEEE bus has caused an SRQ. For this purpose SRE and PPE must be set to the same value. A detailed example of parallel poll is given in section 3.15.16.1.2 Serial Poll SRQ Routine.

Universal Sequence Controller (UPL-B10)	RS-232 interface
See 3.16.4.4 Differences from the IEC-bus Syntax - UPL-B10 Cannot be used	See 3.17.5 Differences to Remote Control via IEC/IEEE Bus Cannot be used

3.7.4.4 Queries

Each individual register of a status register can be read out by queries. The individual queries are given in the detailed description of the registers in Section 3.7.3 Description of Status Registers. The queries always return a number representing the bit pattern of the queried register. This number is evaluated by the controller program.

Queries are mainly used after a SRQ to obtain detailed information on the cause for the SRQ.

3.7.4.5 Error Queue Query

- Each error condition in the instrument causes an entry in the error queue. The entries in the error queue are detailed error messages in plain text which can be read out via IEC/IEEE bus by the query `SYSTem:ERRor?`. Each query `SYSTem:ERRor?` returns an entry from the error queue. If there are no more error messages in the error queue, **0 = "No error"** is returned by the instrument
- The error queue should be queried in the controller program after each SRQ since the queue entries provide a more precise description of the error cause than the status registers. In particular in the test phase of a controller program the error queue should be queried at regular intervals since it also registers faulty commands from the controller to the UPL.

Note:

In addition to an entry in the Error Queue, each error causes a plain-text message to be output on the UPL display so that the IEC/IEEE-bus control program can be checked in the REMOTE control mode without reading out the Error Queue.

3.7.5 Resetting the Status Reporting Systems

Table 3-8 contains the various commands and events causing a reset of the status reporting system. None of the commands, with the exception of *RST affects the functional device setting. In particular DCL does not clear the device settings.

Table 3-8 Resetting of device functions

Event	Effect			
	DCL, SDC (Device Clear, Selected Device Clear)	*RST or SYSTem:PRESet	STATus:PRESet	*CLS
Clears STB, ESR	—	—	—	yes
Clears SRE, ESE	—	—	—	—
Clears PPE	—	—	—	—
Clears EVENt registers	—	—	—	yes
Clears ENABle registers of OPERation, QUESTionable and XQUEStionable Register, fills ENABle registers of all other registers with "1".	—	—	yes	—
Fills PTRansition registers with "1", clears NTRansition registers	—	—	yes	—
Clears Error Queue	—	—	—	yes
Clears output buffer	yes	1)	1)	1)
Clears command processing and input buffer	yes	—	—	—

1) Any command that is the first one in a command line clears the output buffer.

3.8 Notation of Command Table

All commands implemented in the UPL according to the command system are tabulated and described in detail in section 3.10 IEC-bus Commands. The notation is in line with the SCPI standard provided the committee has defined a command for the required function.

Command table in section 3.10 IEC-bus Commands

Command: In this column the complete command without parameters is listed.

Parameter: Here the required parameters and their range of values are stated. If the command is only available in the form of a query, 'Query only' is marked in this column.

Basic unit: Basic unit of physical parameter.

Meaning: Brief description of command.

Section: Reference to the detailed function description in the case of manual operation, mainly section 2 of the UPL manual.

Upper/lower case Upper/lowercase characters are used to differentiate between the long form and the short form of the keywords of a command. The UPL itself does not distinguish between uppercase and lowercase letters.

Special character | For some commands there is a choice of keywords having the same effect. These keywords are stated in the same line and separated by a vertical bar. Only one of these keywords need to be stated in the header of the command. The effect of the command is independent of the keyword selected.

Example: `"SOURce:FREQuency:CW|:FIXed"`
(setting generator to a constant frequency of 1 kHz)

The two commands below have an identical effect
`"SOURce:FREQuency:CW 1E3"≡ "SOURce:FREQuency:FIXed 1E3"`

A vertical bar in the notation of the parameters is used to separate alternative options and is to be seen as "or". The effect of the command differs according to the parameter stated.

Example: Selection of parameters for the command
`"SENSe:VOLTage:UNIT V|DBV|DBU"`
(measurement result may be displayed in Volt, dBV or dBu)

Special characters [ ] Keywords in square brackets may be omitted in compound headers (see section 3.5.3 Structure of a Command Line). For reasons of compatibility with the SCPI standard, the instrument must be able to accept the full length of the command.
Parameters in square brackets may also be optionally inserted in the command or omitted.

Example: `"SENSe[1][:VOLTage|POWer]:REFerence:MODE ..."`
has the same effect as
`"SENSe:REFerence:MODE ..."`
(selecting the method for generating a level reference value)

Parameters in square brackets
may also be optionally inserted in the command or omitted.

Example: TRACe[1] stands for TRACe and TRACe1

TRACe**[1|2]** denotes that either TRACe1 or TRACe2 can be selected, causing **different settings.**
`DISPlay:TRACe[1|2]:MARKer MODE ...`
(markers for FFT spectrum display may be different for TRACe1 and TRACe2)

TRACe**[]** denotes that the command can be used for TRACe1 and TRACe2, causing the **same settings** in both cases.
`DISPlay:TRACe[]:CURSor[1]:MODE ...`
(selected cursor function apply to both traces!)

Special characters { } Parameters in curly brackets may be included in the command as often as required.

Example: `SENSe[1]:LIST:FREQuency <n>{,<n>}`
(frequencies of an RMS-selective sweep)

3.9 Common Commands

The common commands are based on the IEEE 488.2 (IEC 625.2) standard. A specific command has the same effect in different instruments. The headers of these commands consist of an asterisk "*" followed by three letters. Many common commands refer to the status reporting system described in detail in section 3.15 Examples of IEC/IEEE-Bus Programming.

Table 3-9 Common Commands

Command	Brief description	Parameter / Notes	Universal Sequence Controller UPL-B10	RS-232 interface
*CLS	Resets status byte	no query	Not usable	Not usable
*ESE	Sets Event Status Enable Register	0 to 255	Not usable	Not usable
*ESR?	Readout of content of Event Status Register	query only	Usable	Usable
*IDN?	Identification query	ROHDE&SCHWARZ, UPL, 0, 2.xx	Usable	Usable
*IST?	Query for content of IST flag	query only	Not usable	Not usable
*OPC	Synchronization command		Usable	Usable
*PCB	Address for passing back the IEC/IEEE-bus control	0 to 30, no query	Not usable	Not usable
*PRE	Sets Parallel Poll Enable Register	0 to 255	Not usable	Not usable
*RST	Resets the device to a defined default state. The parameter link (see 2.15.8 Transfer of Parameters (Parameter Link Function)) is disabled to maintain the default setting described in Appendix A UPL Default Setup	no query	Usable	Usable
*SRE	Sets Service Request Enable Register	0 to 255	Not usable	Not usable
*STB?	Query for content of Status Byte	query only	Not usable	Not usable
*TRG	Triggers measurement	no query	Usable	Usable
*TST?	UPL selftest	query only	Usable	Usable
*WAI	Synchronization command		Usable	Usable

***CLS**

CLEAR STATUS sets the status byte (STB), the Standard Event Register (ESR) and the EVENt part of the QUEStionable, OPERation and of the XQUEstionable Register to zero. The command has no effect on the mask and transition parts of the register. The output buffer is cleared.

***ESE 0 to 255**

EVENT STATUS ENABLE sets the Event Status Enable Register to the defined value. The query *ESE? returns the content of the Event Status Enable Registers in decimal form.

***ESR?**

EVENT STATUS ENABLE returns the contents of the Event Status Enable Register in decimal form (0 to 255) and clears the register.

***IDN?**

IDENTIFICATION QUERY for identification of the instrument.
The response is for example: "Rohde&Schwarz, UPL, 0, 2.xx"
UPL = instrument designation: 0 = serial number, 2.xx = firmware version

***IST?**

INDIVIDUAL STATUS QUERY returns the contents of the IST flag in decimal form (0 I 1).
The IST flag is the status bit sent during a Parallel Poll (see section 3.7.3.2 IST Flag and Parallel Poll Enable Register (PPE)).

***OPC**

OPERATION COMPLETE sets bit 0 in the Event Status Register if all preceding commands have been executed. This bit may be used to assert a Service Request (see section 3.6.8.3 Comparison of Synchronization Capabilities, 3.7.3.3 Event Status Reg. (ESR), Event Status Enable Reg. (ESE), and section 3.15.15.3 Command Synchronization with *OPC and SRQ

***OPC?**

OPERATION COMPLETE QUERY places an ASCII character "1" in the output buffer as soon as all preceding commands have been executed (see 3.6.8.3 Comparison of Synchronization Capabilities and section 3.15.15.3 Command Synchronization with *OPC and SRQ.

***PCB 0 to 30**

PASS CONTROL BACK notifies the address of the controller to which the IEC/IEEE-bus control is to returned.

***PRE 0 to 255**

PARALLEL POLL REGISTER ENABLE sets the Parallel Poll Enable Register to the defined value. The query *PRE? returns the contents of the Parallel Poll Enable Registers in decimal form

***RST**

RESET sets the UPL to a defined default state. The parameter-Link (see 2.15.8 Transfer of Parameters (Parameter Link Function)) is switched off to ensure that the default state as described in Annex A UPL Default Setup is maintained after a change of instrument or function.

***SRE 0...255**

SERVICE REQUEST ENABLE sets the Service Request Enable Register to the defined value. Bit 6 (MSS mask bit) remains 0. This command determines the conditions under which a Service Request will be asserted. The query *SRE? outputs the contents of the Service Request Enable Registers in decimal form.
Bit 6 is always 0.

***STB?**

READ STATUS BYTE QUERY outputs the contents of the status byte in decimal form.
Its contents are not set to zero during reading.
If the EVENt part of a status register is read, the associated bit in the status byte register is deleted (eg STAT:OPER:EVEN? deletes the OPER bit (d7) in the OPERation register).

***TRG**

TRIGGER starts all actions waiting for a trigger event.
See sections 3.6.7 Triggering a Measurement/Sweep; 3.6.8.2 Wait for End of Measurement/Sweep and section 3.15.8.1 Readout of Triggered Measurements.

***TST?**

SELF TEST QUERY causes a brief selftest of the UPL and outputs an error code in decimal form ('0' for ok., '1' for error)

***WAI**

WAIT-to-CONTINUE allows processing of commands only after all preceding commands have been executed, all signals settled and current measurements are terminated (see sections 3.6.8.2 Wait for End of Measurement/Sweep, 3.6.8.3 Comparison of Synchronization Capabilities, and section 3.15.15.1 Command Synchronization with *WAI.

IEC/IEEE-Bus Commands
Selection of Generator • Configuration of Analog Generators • Configuration of Digital Generators • Generator Sweeps • Generator Functions

IEC/IEEE-Bus Commands for Analyzers
Selection of Analyzer • Configuration of Analog Analyzers • Configuration of Digital Analyzers • Starting the Analyzer, Ext. Sweep • Analyzer Functions

Selection of Analyzer Filter

Units for IEC/IEEE Measurement Results

Loading and Storing
Loading and Storing Instrument Setups • Loading and Storing Traces and Lists

Commands for Graphical Representation of Results

Commands for Printing/Plotting of Screen and Storing in Files

Setting and Display of Auxiliary Parameters
IEC/IEEE-Bus Address • Keyboard Settings • Macro Operating • Display Settings • Setting and Switching Off the Displays • Version Display • Calibration • Transfer of Settings • Parameters of COM2 Interface • Loading Speed for Setups and Analyzer Measurement Functions

Commands for Data Output
Commands for Input/Output of Block Data
Commands for Status and Error Queries
Commands for Synchronization
Settings without Corresponding IEC/IEEE-Bus Command

Alphabetical List of IEC/IEEE-Bus Commands

3.10 IEC/IEEE-Bus Commands

3.10.1 Generators

3.10.1.1 Selection of Generator

Command	Parameter	Basic unit	Meaning	Section
INSTrument[1][:SELect] equivalent to **INST**rument[1]:**NSEL**ect	***A25*** ***D48*** **1** **3**		→ Analog generator, 25 kHz → Digital generator, 48 kHz → Analog generator, 25 kHz → Digital generator, 48 kHz	**2.5.1** **GEN panel** INSTRUMENT → ANLG → DIG 48 kHz

3.10.1.2 Configuration of Analog Generators

Command	Parameter	Basic unit	Meaning	Section
OUTPut:***SEL****ect***	***OFF*** ***CH1*** ***CH2*** ***CH2Is1***		→ Generator channels switched off → Only generator channel 1 active → Only generator channel 2 active → Both generator channels active	**2.5.2** **GEN panel** Channel(s) → OFF → 1 → 2 → 2 ≡ 1
OUTPut:***TYPE***	***BAL****anced* ***UNB****alanced*		→ Balanced output (XLR connector) → Unbalanced output (BNC connector)	**2.5.2** **GEN panel** Output → BAL → UNBAL

Command	Parameter	Basic unit	Meaning	Section
OUTPut:**IMP**edance	***R10*** ***R200*** ***R150*** *(Query reply. = R200)* ***R600***		Only for OUTPut:TYPE Bal → Output impedance 10 Ω → Output impedance 200 Ω → Output impedance 150 Ω, if the standard generator source impedance was changed from 200 Ω to 150 Ω using Modification Analog Generator UPL-U3 (Order No. 1078.4900.02) → Output impedance 600 Ω	2.5.2 **GEN panel** Impedance → 10 Ω → 200 Ω (→ 150 Ω) → 600 Ω
SOURce:**VOLT**age:**RANG**e:**AUTO**	**ON** **OFF**		Range selection for setting the generator output voltage. → D/A converters operating at full range. The output voltage is set using the output amplifier. Optimum noise and THD values. Any maximum voltage can be entered with command SOUR:VOLT:LIM <nu>, higher voltages are not permissible. → The output amplifier is set to the maximum voltage specified by the next command; higher voltages are not permissible. The current output voltage is attained with the smaller digital values of the D/A converter. Setting the analog hardware is not required for changing the output voltage. Advantage: fast level changes and better transient response.	**2.5.2** **GEN panel** Volt Range → AUTO → FIX
SOURce:**VOLT**age:**LIM**it[:AMPLitude]	**<nu>** 0 to 20 V	V	Output voltage limit for command SOUR:VOLT:RANG:AUTO OFF preventing too high voltages to be entered.	**2.5.2** **GEN panel** For Volt Range = AUTO, Max Volt is displayed, for Volt Range = FIX, a numeric value.
SOURce:**FREQ**uency:***REF**erence*	**<nu>** 1 MHz to 1 MHz	Hz	Reference frequency	2.5.2 **GEN panel** Ref.Freq

Command	Parameter	Basic unit	Meaning	Section
SOURce:VOLTage:REFerence	<nu> 1µV to 1 MV	V	Reference voltage	2.5.2 **GEN panel** Ref.Volt
OUTPut	**ON**		→ Switches all outputs on. After an overload of analyzer inputs (input voltage into 300 Ω and 600 Ω above 25 V), the input impedance is automatically switched to 200 kΩ to protect the analyzer input and the generator output is switched off. This command switches the generator on again and measurements can be continued provided the overvoltage is eliminated or the input impedance switched to 200 kΩ (INP:IMP R200K). The overload protection of the analyzer iniputs is valid for analog board versions ≥ 4.00 and software versions ≥ 1.0.	2.13 Taste OUTPUT OFF
	OFF		→ Switches all outputs off including clock lines of digital interfaces. See 2.13 Fast Switch-off of Outputs.	

3.10.1.3 Configuration of Digital Generators

Command	Parameter	Basic unit	Meaning	Section
SOURce:DIGital:FEED	*ADATa* *JITTer* *PHASe* *COMMon*		Use of generator data: → Generator controls the audio content of the output → Generator controls the jitter modulator of the digital interface → Same as JITTer with additional phase offset. → Generator controls common-mode voltage at digital output	2.5.3 **GEN panel** Src Mode → AUDIO DATA → JITTER ONLY → PHASE → COMMON ONLY
SOURce:DIGital:SYNC:DELay	<nu>	UI see 2.5.3.1	Setting a phase offset for SOUR:DIG:FEED JPHase	2.5.3.1 **GEN panel** Phase ToRef
OUTPut:*SELect*	*OFF* *CH1* *CH2* *CH2Is1*		→ Generator channels off → Only generator channel 1 active → Only generator channel 2 active → Both generator channels active and in phase	2.5.3 **GEN panel** Channel(s) → OFF → 1 → 2 → 2 ≡ 1
OUTPut:DIGital:UNBalanced:FEED	*AOUTput* *AINPut*		→ Same channel present at BNC and XLR connectors → Input signal through-connected and output at BNC connector	2.5.3 **GEN panel** Unbal Out → AUDIO OUT → AUDIO IN
OUTPut:DIGital:CSIMulator	*OFF* *SIMLong*		A 100-m cable of 110-Ω nominal impedance is simulated and cut into the generator output. → Cable simulation switched off → Cable simulation switched on	2.5.3 **GEN panel** Cable Sim → OFF → LONG CABLE

Command	Parameter	Basic unit	Meaning	Section
SOURce:DIGital:SYNC:SOURce	*GCLock* *AINPut* *RINPut* *SINPut*		→ The clock is generated in the UPL. Selectable: 32, 44.1 or 48 kHz and 27 to 55 kHz variable. → Generator clock from analyzer input. → Generator clock from rear reference input → Generator clock controlled via rear BNC connector. The mark-to-space ratio can be set with command SOUR:DIG:SYNC:MODE to .	2.5.3 **GEN panel** Sync Out → GEN CLK → AUDIO IN → REF IN → SYNC IN
SOURce:DIGital:SYNC:MODE	*V50* *V60* *WCLock* *IWCLock* *F1024*		→ The generator sampling rates of 32, 44.1 and 48 kHz are synchronized to the 50-Hz video repetition rate. → Same as V50, but for 60 Hz (NTSC). → Generator directly synchronized to applied word clock using PLL. → Same as WCLock but with the inverted input used for synchronization. → Synchronization to a "customized clock", eg in the case of DAB	2.5.3 **GEN panel** Sync Mode → VIDEO 50 → VIDEO 60 → WORD CLK → WRD CLK INV → 1024 kHz
OUTPut:SAMPle[:FREQuency]:MODE	*F32* *F44* *F48* *EXTern* *SYNChron* *VALue*		→ Sampling frequency 32 kHz → Sampling frequency 44.1 kHz → Sampling frequency 48 kHz → External sample frequency. Refer to next command for input values. → Sampling frequency synchronized to analyzer. → Sampling frequency entered with next command.	2.5.3 **GEN panel** Sample Freq → 32 kHz → 44.1 kHz → 48 kHz → EXTERN → SYNCHRON → VALUE:
OUTPut:*SAMPle*:FREQuency	**<nu>** 30 kHz to 52.5 kHz	Hz	External sample frequency for digital instrument.	2.5.3 **GEN panel**
OUTPut:DIGital:SYNC:FEED	 *AIPut* *GCLock* *RINPut* *SPLL*		Specifies the signal to be output at rear BNC connector for synchronization. → Audio input signal output without clock processing. → Output of internal generator clock. → Same as GCLock, but reference input. → Audio input signal output after clock processing with internal PLL.	2.5.3 **GEN panel** Sync Out → AUDIO IN → GEN CLK → REF IN → SYNC PLL

Command	Parameter	Basic unit	Meaning	Section
OUTPut:DIGital:SYNC:TYPE	*WCLock* *BCLock*		Specifies the signal type for OUTPut:DIGital:SYNC:FEED ..... . → Sampling frequency → 128 times the sampling frequency	2.5.3 **GEN panel** Type → WORD CLK → BIPHASE CLK
OUTPut:DIGital:REFerence:FEED	*AINPut* *AINReclock* *AOUTput* *RGENerator*		Specifies the signal to be output at the Ref-Out connector. → The input is throughconnected. → The input signal is output again; the clock is processed via PLL using the internal clock ("jitter suppression"). → The same signal as on the front panel is output. → Reference generator output. For an output with phase the reference is defined.	2.5.3 **GEN panel** Ref Out → AUDIO IN → AUD IN RCLK → AUDIO OUT → REF GEN
SOURce:DIGital:REFerence	*AZERo* *AONE*		All data of the reference generator are → 0 → 1	2.5.3 **GEN panel** Data → ALL ZERO → ALL ONE
SOURce:VOLTage:LIMit[:AMPLitude]	**<nu>** 0 to 1 FS	FS	Voltage limitation (for audio data only)	2.5.3 **GEN panel** Max Volt
SOURce:*FREQuency:REFerence*	**<nu>** 1 MHz to 1 MHz	Hz	Reference frequency	2.5.3 **GEN panel** Ref.Freq
SOURce:Voltage:*REFerence*	**<nu>** 10 nFS to 100 Fs	Hz	Reference level	2.5.3 **GEN panel** Ref Volt
OUTPut:*AUDiobits*	**<n>** 8 to 24		Word length of audio samples in bits.	2.5.3 **GEN panel** Audio Bits

Command	Parameter	Basic unit	Meaning	Section
OUTPut:**SIGN**al: **LEV**el	**<nu>**	Vpp	Voltage at Unbal AES output	2.5.3 **GEN panel** Unbal Vpp
OUTPut:**SIGN**al:**BAL**anced**:LEV**el	**<nu>** 0 to 8.5 V		Setting the output voltage of the digital signal at the BAL (XLR) interface. Peak-to-peak voltage upon termination with nominal impedance (110 Ω); without termination the voltage is twice as high. This voltage is always 4 times as high as the voltage at the UNBAL (BNC) interface.	2.5.3 **GEN panel** BAL Vpp

3.10.1.3.1 AES / EBU PROTOCOL Definition

Command	Parameter	Basic unit	Meaning	Section
SOURce:**PROT**ocol	*OFF* *STATic* *ENHanced*		→ If the generated channel status data are of no interest, the undesired menu lines are removed from the generator panel. Channel status data cannot be entered. The last-defined status remains unchanged. → Only basic channel status data can be generated (RAW data identical in both channels have to be defined via a file) This mode can always be used without any restriction. → Selectable only with option UPL-B21 (digital audio protocol) fitted. All protocol commands are displayed in the GENERATOR panel where the full scope of protocol data generation can be entered and displayed. In this mode the analyzer must also be set to protocol analysis. Therefore, when switching on ENHANCED the following settings are made automatically in the analyzer panel: • INSTRUMENT DIGITAL (INST2 D48) • Meas Mode AUDIO DATA (SENS:DIG:FEED ADAT) • FUNCTION PROTOCOL (SENS:FUNC 'PROT') Conversely, this function is set to OFF as soon as one of the three named analyzer menu lines is changed.	2.5.3.2 **ANA panel** PROTOCOL → PANEL OFF → STATIC → ENHANCED
OUTPut:***VAL**idity*	*CH1And2* *NONE*		Sets the validity bits in the AES/EBU data stream. → Valid bit for both channels set. → Valid bit for none of the channels set	2.5.3.2 **GEN panel** Validity
SOURce:***PROT**ocol:**LCH**annelstatus*	*ZERO* *AES3* *CRC* *RAW*		Specifies how the channel status data for LEFT are to be generated. → All channel status data bits are 0 → UPL generates local timecode and CRC. All other channel status data are defined by the file loaded with command MMEMory:LOAD: LPGC **"filename"**. → Same as AES3, however local timecode is not generated by UPL but set as a fixed value from the file. → Same as AES3, however neither local timecode nor CRC is generated by UPL but set as fixed values from the file.	2.5.3.2 **GEN panel** Ch Sta. L → ZERO → FILE+AES3 → FILE+CRC → FILE
MMEMory:**LOAD:*LPGC***	**"filename"**		Stating a file containing channel status data for LEFT. Preset file type: * ·pgc	2.5.3.2 **GEN panel** Filename

Command	Parameter	Basic unit	Meaning	Section
SOURce:*PROTocol:RCHannelstatus*	**ZERO** **LEQual** **AES3** **CRC** **RAW**		Specifies how the channel status data RIGHT are to be generated. → All channel status data bits are 0 → The two sides are identical, all definitions made for left are copied to the right side. The operating mode is defined by Ch. Stat L. → UPL generates local timecode and CRC. All other channel status data are defined by the file loaded with command MMEMory:LOAD:RPGC "filename". → Same as AES3-..., however local timecode not generated by UPL but set as a fixed value from the file. → Same as AES3-..., however neither local timecode nor CRC is generated by UPL but set as fixed values from the file.	2.5.3.2 **GEN panel** Ch Stat. R → ZERO → EQUAL L → FILE+AES3 → FILE+CRC → FILE
MMEMory:LOAD:*RPGC*	**"filename"**		Stating a file containing channel status data for RIGHT. Preset file type: *.prd	2.5.3.2 **GEN panel** Filename
SOURce:*PROTocol:UMODe*	**ZERO** **FILE**		Specifies how user data are to be generated. → All user bits are initialized to be 0. → User bits are output according to the definitions in the file loaded with command MEMory:LOAD:PGU "filename".	2.5.3.2 **GEN panel** User Mode → ZERO → FILE DEF
MMEMory:LOAD:*PGU*	**"filename"**		Stating a file containing USER data Preset data type: *.prd	2.5.3.2 **GEN panel** Filname

3.10.1.3.2 Auxiliary AUX GEN

Command	Parameter	Basic unit	Meaning	Section
SOURce2:FUNCtion	**OFF** **ANLGout** **COMMon** **JITTer**		→ Auxiliary generator switched off, audio data generated without interference signal, analog outputs switched off (high-impedance). → Audio data generated without interference signal, an analog signal is generated at the analog XLR connectors in addition to the digital signal at the BAL, UNBAL and optical outputs. Frequency and level of the analog signal can be set or swept. → A common-mode interference signal is superimposed on the audio data, the analog outputs are switched off (high-impedance). Frequency and level of the interference signal can be set or swept → A jitter signal is added to the audio signal, the analog outputs are switched off (high-impedance). Jitter frequency and level can be set or swept. Permissible only for digital generator in the Src Mode AUDIO DATA I PHASE (INST D48 with SOUR:DIG:FEED ADATIPHAS)	**2.5.5** **GEN panel** → OFF → ANALOG OUT → COMMON MODE → JITTER
OUTPut2:SELect	*OFF* *CH1* *CH2* *CH2Is1*		Selection of output channel when the auxiliary generator is used as an analog generator (SOUR2:FUNC ANLG). The low-distortion generator is used, level control is via the output amplifier. → Both channels off → Channel 1 on, channel 2 off → Channel 2 on, channel 1 off → Same signal on both channels	**2.5.5** **GEN panel** Channel(s) → OFF → 1 → 2 → 2 ≡ 1
OUTPut2:TYPE	**UNBalanced** **BALanced**		Selection of output channel when the auxiliary generator is used as an analog generator (SOUR2:FUNC ANLG). → An unbalanced signal is generated at the XLR connector; the maximum output level is 10 V. → A balanced signal is generated at the XLR connector, the maximum output level is 20 V. The output impedance can be selected in three steps with the subsequent command.	**2.5.5** **GEN panel** Output → UNBAL → BAL

Command	Parameter	Basic unit	Meaning	Section
OUTPut2:IMPedance	**R10** **R200** **R600**		Selection of output impedance when the auxiliary generator is used as an analog generator (SOUR2:FUNC ANLG) and OUTP2:TYPE BAL is selected; the output impedance of the unbalanced output is generally 5 Ω. → 10 Ω → 200 Ω → 600 Ω	**2.5.5 GEN panel** Impedance → 10 Ω → 200 Ω → 600 Ω
SOURce2:SWEep ...			The auxiliary generator has its own sweep system which is similar to that of the function generator. 2-dimensional sweep, ie simultaneous frequency and level sweep, is not implemented. **The commands permissible for the auxiliary generator are listed in section** 3.10.1.4.1 Sweep Settings for Auxiliary Generator (AUX GEN).	**2.5.4.2 GEN-Panel**
SOURce2:FREQuency[:CWIFIXed]	**<nu>** 10 Hz to 110 kHz	Hz	For SOUR2:FUNC ANLG: Entry of sinewave frequency of analog signal For SOUR2:FUNC COMM: Entry of common-mode frequency For SOUR2:FUNC JITT: Entry of jitter frequency	**2.5.5 GEN panel** Depending on AUX GEN: → Anlg Freq → Comm Freq → JittPkFreq
SOURce2:VOLTage[:LEVellAMPLitude]	**<nu>** 0 to 7.07 V 0 to 7.07 V 0 to 250 mUI	V V UI	For SOUR2:FUNC ANLG: Entry of sinewave amplitude of analog signal For SOUR2:FUNC COMM: Entry of common-mode amplitude For SOUR2:FUNC JITT: Entry of jitter-peak amplitude	**2.5.5 GEN panel** Depending on AUX GEN: → Anlg Ampl → Comm Ampl → JittPkAmpl

3.10.1.4 Generator Sweeps

3.10.1.4.1 Sweep Settings for Auxiliary Generator (AUX GEN)

Command	Parameter	Basic unit	Meaning	Section
SOURce2:SWEep:MODE	**MANual** **AUTO**		Auxiliary generator: → Manual sweep trigger → Automatic sweep trigger	**2.5.4.2 Sweeps GEN panel** Sweep Ctrl
SOURce2:SWEep:*NEXTstep*	***DWELl*** ***ASYNc*** ***LIST***		Auxiliary generator: → Sweep trigger at fixed preset time → Sweep triggered when a valid result is obtained → Sweep trigger is time-controlled by interpolated list value Permissible for AUTO SWEEP and AUTO LIST only (SOUR2:SWE:MODE AUTO;:SOUR2:FREQ|VOLT:MODE SWE1|LIST1)	**2.5.4.2 Sweeps GEN panel** Next Step → ANLR SYNC → DWELL VALUE → DWELL FILE
SOURce2:SWEep:DWELl	**<nu>** 10 ms to 1000 s	s	Auxiliary generator: Dwell time for each sweep step Permissible for SOUR2:SWE:NEXT DWEL only.	**2.5.4.2 Sweeps GEN panel** Dwell
MMEMory:LOAD:LIST	**DWELl2,'filename'** Query: MMEM:LOAD:LIST? DWEL2		Specified file contains dwell times Permissible for SOUR2:SWE:NEXT LIST only	**2.5.4.2 Sweeps GEN panel** Dwell File
SOURce2:FREQuency:MODE	**CW | FIXed** **SWEep1** **LIST1**		Auxiliary generator: → Frequency setting by entry using command SOUR2:FREQ <nu> → Frequency setting for X axis via normal sweep → Frequency setting for X axis via list sweep	**2.5.4.2 Sweeps GEN panel** SWEEP CTRL X Axis

Command	Parameter	Basic unit	Meaning	Section
SOURce2:**SWE**ep:**FREQ**uency:**SPAC**ing	**LIN**ear **LOG**arithmic		Auxiliary generator: Division of sweep range for - frequency sweep of analog signal (SOUR2:FUNC ANLG) - comon-mode frequency sweep (SOUR2:FUNC COMM) - jitter frequency sweep (SOUR2:FUNC JITT) → linear → logarithmic Permissible for SOUR:FREQ:MODE SWE1 only	**2.5.4.2 Sweeps** **GEN panel** Spacing → LIN → LOG
SOURce2:**FREQ**uency:**STAR**t	**<nu>** 10 Hz to 110 kHz	Hz	Auxiliary generator: Start value for frequency sweep Permissible for SOUR:FREQ:MODE SWE1 only	**2.5.4.2 Sweeps** **GEN panel** FREQUENCY Start
SOURce2:**FREQ**uency:**STOP**	**<nu>** 10 Hz to 110 kHz	Hz	Auxiliary generator: Stop value of frequency sweep Permissible for SOUR:FREQ:MODE SWE1 only	**2.5.4.2 Sweeps** **GEN panel** FREQUENCY Stop
SOURce2:**SWE**ep:**FREQ**uency:**POIN**ts	**<n>** 2 to 1024		Auxiliary generator: Number of sweep points of frequency sweep Permissible for SOUR:FREQ:MODE SWE1 only	**2.5.4.2 Sweeps** **GEN panel** FREQUENCY Points
SOURce2:**SWE**ep:**FREQ**uency:**STEP**	**<nu>** depending on STARt and STOP	Hz	Auxiliary generator: Step width of frequency sweep Permissible for SOUR:FREQ:MODE SWE1 only	**2.5.4.2 Sweeps** **GEN panel** FREQUENCY Step
MMEMory:**LOAD:LIST**	**FREQ**uency**2**,**'file'** Query MMEM:LOAD:LIST? FREQ2		File containing frequency values Permissible for SOUR2:SWE:MODE AUTOIMAN;:SOUR2:FREQ:MODE LIST1 only	**2.5.4.2 Sweeps** **GEN panel** FREQ FILE
SOURce2:**VOLT**age:**MODE**	**CW** | **FIX**ed **SWE**ep**1** **LIST1**		Auxiliary generator: → Amplitude setting by entry using command SOUR2:VOLT <nu> → Amplitude setting via normal sweep, amplitude as X axis → Amplitude setting via list sweep, amplitude as X axis	**2.5.4.2 Sweeps** **GEN panel** SWEEP CTRL X Axis

Command	Parameter	Basic unit	Meaning	Section
SOURce2:SWEep:VOLTage:SPACing	**LIN**ear **LOG**arithmic		Auxiliary generator: Division of sweep range for - sinewave amplitude of analog signal (SOUR2:FUNC ANLG) - common-mode amplitude (SOUR2:FUNC COMM) - jitter-peak amplitude (SOUR2:FUNC JITT) → linear → logarithmic Permissible for SOUR2:VOLT:MODE SWE1 only	**2.5.4.2 Sweeps GEN panel** VOLTAGE I AMPL Spacing → LIN → LOG
SOURce2:VOLTage:STARt	**<nu>** 0 to 7.07 V 0 to 7.07 V 0 to 250 mUI	 V V UI	Auxiliary generator: Start value for amplitude sweep Permissible for SOUR2:VOLT:MODE SWE1 only	**2.5.4.2 Sweeps GEN panel** VOLTAGE I AMPL Start
SOURce2:VOLTage:STOP	**<nu>** 0 to 7.07 V 0 to 7.07 V 0 to 250 mUI	 V V UI	Auxiliary generator: Stop value for amplitude sweep Permissible for SOUR2:VOLT:MODE SWE1 only	**2.5.4.2 Sweeps GEN panel** VOLTAGE I AMPL Stop
SOURce2:SWEep:VOLTage:POINts	**<n>** 2 to 1024		Auxiliary generator: Number of sweep points of amplitude sweep Permissible for SOUR2:VOLT:MODE SWE1 only	**2.5.4.2 Sweeps GEN panel** VOLTAGE I AMPL Points
SOURce2:SWEep:VOLTage:STEP	**<nu>** depending on STARt and STOP	V FS	Auxiliary generator: Step width for amplitude sweep Permissible for SOUR2:VOLT:MODE SWE1 only	**2.5.4.2 Sweeps GEN panel** VOLTAGE I AMPL Step
MMEMory:LOAD:LIST	**VOLTage2,'filename'** Query: MMEM:LOAD:LIST? VOLT2		File containing amplitude values Permissible for SOUR2:SWE:MODE AUTOIMAN;:SOUR2:VOLT:MODE LIST1 only	**2.5.4.2 Sweepss GEN panel** VOLTAGE I AMPL VOLT FILE

3.10.1.4.2 Sweep Settings for Generator Functions SINusoid, BURSt, S2Pulse, MDISt and DFD

- With a BURSt and S2Pulse sweep the burst frequency and/or the level is swept, likewise Ontime and/or interval (see next section).
- With a SINusoid sweep the sinusoidal frequency and/or the level is swept.
- With a MDISt sweep the upper frequency and/or the total voltage is swept.
- With a DFD sweep the center frequency and/or the total voltage is swept.

Command	Parameter	Basic unit	Meaning	Section
SOURce:**SWE**ep:**MODE**	**MAN**ual **AUTO**		→ Manual sweep switching → Automatic sweep switching	**2.5.4.1.3** **GEN panel** Sweep Ctrl
SOURce:**SWE**ep:***NEXT**step*	***DWEL**l* ***ASYN**c* ***LIST***		→ Sweep after a certain (fixed) time has elapsed → Sweep after a valid measured value has been obtained → Sweep after a certain time defined by interpolated list value	**2.5.4.1.3** **GEN panel** Next Step → ANLR SYNC → DWELL VALUE → DWELL FILE
SOURce:**SWE**ep:**DWEL**l	**<nu>** 10 ms to 1000 s	s	Dwell time per sweep	**2.5.4.1.3** **GEN panel** Dwell
MMEMory:**LOAD:LIST**	**DWEL**l,**'filename'** Query: MMEM:LOAD:LIST? DWEL		Specified file contains the dwell times	**2.5.4.1.3** **GEN panel** Dwell File
SOURce:**FREQ**uency:**MODE**	**CW** | **FIX**ed **SWE**ep1 **SWE**ep2 **LIST1** **LIST2**		→ Frequency setting via entry → Frequency setting via normal sweep; frequency as X axis → Frequency setting via normal sweep; frequency as Z axis → Frequency setting via list sweep; frequency as X axis → Frequency setting via list sweep; frequency as Z axis	**2.5.4.1.3** **GEN panel** SWEEP CTRL X Axis Z Axis

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FREQ**uency:**STAR**t	**<nu>** Value range determined by instrument or function	Hz	Start value for frequency sweep	**2.5.4.2** **GEN panel** FREQUENCY → Start
SOURce:**FREQ**uency:**STOP**	**<nu>** Value range determined by instrument or function	Hz	Stop value for frequency sweep	**2.5.4.2** FREQUENCY → Stop
SOURce:**SWE**ep:***FREQ**uency*:**POIN**ts	**<n>** 2 to 1024		For analog instrument Number of sweep points for frequency sweep	**2.5.4.2** **GEN panel** Points
SOURce:**SWE**ep:***FREQ**uency*:**SPAC**ing	 **LIN**ear **LOG**arithmic		Scaling of frequency sweep range → linear → logarithmic	**2.5.4.2** **GEN panel** Spacing
SOURce:**SWE**ep:***FREQ**uency*:**STEP**	**<nu>**	Hz	Step width for frequency sweep	**2.5.4.2** **GEN panel** Step
MMEMory:**LOAD**:***LIST***	**FREQ**uency[1] "**filename**" Query: MMEM:LOAD:LIST? FREQ,		File containing frequencies	**2.5.4.2** **GEN panel** FREQ FILE
SOURce:**VOLT**age:**MODE**	**CW** | **FIX**ed **SWE**ep1 **SWE**ep2 **LIST1** **LIST2**		→ Amplitude setting via entry → Amplitude setting via normal sweep; amplitude as X axis → Amplitude setting via normal sweep; amplitude as Z axis → Amplitude setting via list sweep; amplitude as X axis → Amplitude setting via list sweep; amplitude as Z axis	**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis
SOURce:**VOLT**age:**STAR**t	**<nu>** Value range determined by instrument or function	V FS	Start value for amplitude sweep	**2.5.4.2** **GEN panel** VOLTAGE → Start

Command	Parameter	Basic unit	Meaning	Section
SOURce:VOLTage:STOP	**<nu>** Value range determined by instrument or function	V FS	Stop value for amplitude sweep	**2.5.4.2** **GEN panel** VOLTAGE → Stop
SOURce:SWEep:*VOLTage*:POINts	**<n>** ***2 to 1024***		Number of sweep points for amplitude sweep	**2.5.4.2** **GEN panel** Points
SOURce:SWEep:*VOLTage*:SPACing	***LINear*** **LOG**arithmic		Scaling of amplitude sweep range → linear → logarithmic	**2.5.4.2** **GEN panel** Spacing → LIN → LOG
SOURce:SWEep:*VOLTage*:STEP	**<nu>** Value range determined by instrument or function	V FS	Step width for amplitude sweep	**2.5.4.2** **GEN panel** Step
MMEMory:LOAD:LIST	**VOLTage,'filename'** Query: MMEM:LOAD:LIST? VOLT		File containing amplitude values	**2.5.4.2** **GEN panel** VOLT FILE
SOURce:*OFF*:MODE	**SWEep2 | LIST2**		Switches a Z sweep off which was switched on with one of the following commands. SOURce:FREQuency:MODE SWEep2 / LIST2 or SOURce:VOLTage:MODE SWEep2 / LIST2 or SOURce:ONTime:MODE SWEep2 / LIST2 or SOURce:INTerval:MODE SWEep2 / LIST2 SWEep2 and LIST2 are synonyms in this command	**2.5.4.2** **GEN panel** Z Axis → OFF

Note: Max. 2 sweep parameters can be selected not to equal CW (= FIXed). Combining SWEep and LIST is not permissible. Likewise, assignment of the same selection point (eg SWEep1) to different sweep parameters is not permissible; the selection made most recently is valid, the other sweep parameters are set to FIXed.

A normal sweep (or list sweep) is possible only when exactly 1 sweep parameter is set to SWEep1 (or LIST1).
The sweep system is switched off when all sweep parameters are set to CW (=FIXed).
Value range for "STARt", "STOP": values are specified in the functions section.

3.10.1.4.3 Sweep Settings for Generator Functions BURSt and S2Pulse

Sweep settings same as with SINusoid, but for BURSt and S2Pulse **Ontime** and **Interval** may be swept in addition:

Command	Parameter	Basic unit	Meaning	Section
SOURce:*ONTime*:**MODE**	**CW | FIX**ed **SWE**ep1 **SWE**ep2 **LIST1** **LIST2**		→ Burst time setting via entry → Burst time setting via normal sweep; burst time as X axis → Burst time setting via normal sweep; burst time as Z axis → Burst time setting via list sweep; burst time as X axis → Burst time setting via list sweep; burst time as Z axis	**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis
SOURce:*INTerval*:**MODE**	**CW | FIX**ed **SWE**ep1 **SWE**ep2 **LIST1** **LIST2**		→ Interval setting via entry → Interval setting via normal sweep; interval as X axis → Interval setting via normal sweep; interval as Z axis → Interval setting via list sweep; interval as X axis → Interval setting via list sweep; interval as Z axis	**2.5.4.2** **GEN panel** SWEEP CTRL X Axis Z Axis
SOURce:*ONTime*:**STAR**t	**<nu>** Value range determined by instrument or function	s, cyc	Start value for burst time sweep	**2.5.4.2** 2.5.4.5 2.5.4.6 **GEN panel** Start
SOURce:*ONTime*:**STOP**	**<nu>** Value range determined by instrument or function	s, cyc	Stop value for burst time sweep	**2.5.4.2** 2.5.4.5 2.5.4.6 **GEN panel** Stop
SOURce:**SWE**ep:*ONTime*:**POIN**ts	**<n>** 2 to 1024		Number of sweep points of burst time sweep	**2.5.4.2** **GEN panel** Points
SOURce:**SWE**ep:*ONTime*:**SPAC**ing	**LIN**ear **LOG**arithmic		Scaling of burst time sweep range → linear → logarithmic	**2.5.4.2** **GEN panel** Spacing → LIN → LOG

Command	Parameter	Basic unit	Meaning	Section
SOURce:**SWE**ep:***ONT**ime*:**STEP**	**<nu>** Value range determined by instrument or function	s, cyc	Step size for burst time sweep	**2.5.4.2** **GEN panel** Step
MMEMory:**LOAD:LIST**	**ONT**ime,'**filename**' Query: MMEM:LOAD:LIST? ONT		File containing burst time values	2.5.4.5 2.5.4.6 **GEN panel** ONTIM FILE
SOURce:***INT**erval*:**STAR**t	**<nu>** Value range determined by instrument or function	s	Start value for interval sweep	**2.5.4.2** 2.5.4.5 2.5.4.6 **GEN panel** Start
SOURce:***INT**erval*:**STOP**	**<nu>** Value range determined by instrument or function	s	Stop value for interval sweep	**2.5.4.2** 2.5.4.5 2.5.4.6 **GEN panel** Stop
SOURce:**SWE**ep:***INT**erval*:**POIN**ts	**<n>** 2 to 1024		Number of sweep points for interval sweep	**2.5.4.2** **GEN panel** Points
SOURce:**SWE**ep:***INT**erval*:**SPAC**ing	**LIN**ear **LOG**arithmic		Scaling of interval sweep range → linear → logarithmic	**2.5.4.2** **GEN panel** Spacing → LIN → LOG
SOURce:**SWE**ep:***INT**erval*:**STEP**	**<nu>** Value range determined by instrument or function	s	Step size for interval sweep	**2.5.4.2** **GEN panel** Step

Command	Parameter	Basic unit	Meaning	Section
MMEMory:**LOAD:LIST**	*INTerval*, '**filename**' Query: MMEM:LOAD:LIST? INT		File containing interval values	2.5.4.5 2.5.4.6 **GEN panel** INTV FILE

3.10.1.5 Generator Functions

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	***SIN**usoid* **MUL**Tisine ***BURS**t* **S2P**ulse **MDIS**t **DFD** ***RAND**om* ***USER*** **POL**arity *FSK*		Generator signal: → Sinusoidal tone → Multi-tone (up to 17 sine lines) → Sine burst → Sine^2 burst → Double sine (similar to SMPTE) → Double sine (difference frequency distortion method) → Noise → User-defined signals → Polarity test signal → Frequency shift keying	2.5.4 **GEN panel** FUNCTION → SINE → MULTISINE → SINE BURST → SINE² BURST → MOD DIST → DFD → RANDOM → ARBITRARY → POLARITY → FSK

3.10.1.5.1 SINE

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion [:SHAPe]	**SIN**usoid		→ Sinusoidal tone	2.5.4.3 **GEN panel** FUNCTION → SINE
SOURce:**FREQ**uency:***OFFSet:*****STATe**	**ON** **OFF**		→ Frequency offset 0.1 % → No frequency offset	2.5.4.1 **GEN panel** Frq. Offset
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed to the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low-distortion generator is used.*	2.5.4.1 **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<n>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.1 **GEN panel** DC Offset
SOURce:***SIN**usoid:**DITH**er:***STATe**	**ON** **OFF**		→ Noise superimposed on signal → Noise superimposition off For digital instrument only	2.5.4.1 **GEN panel** Dither → ON → OFF
SOURce:***SIN**usoid:**DITH**er*	**<nu>** 0 to 1 FS	FS	Noise amplitude	2.5.4.1 **GEN panel** Dither

Command	Parameter	Basic unit	Meaning	Section
SOURce:*RAND*om:*PDF*	**GAUS**sian **TRI**angle **RECT**angle		→ Noise distribution, Gaussian → Noise distribution, triangular → Noise distribution, uniform	2.5.4.1 **GEN panel** PDF → GAUSS → TRIANGLE → RECTANGLE
SOURce:*LOWDistortion*	**ON** **OFF**		→ Sine signal generated by LDG → Sine signal generated by function generator	2.5.4.1 2.5.4.3 **GEN panel** Low Dist → ON → OFF
SOURce:**SWE**ep ...			For sweep commands see 3.10.1.4 Generator Sweeps	
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>** Value range determined by instrument or function	Hz	Sine frequency	2.5.4.3 **GEN panel** FREQUENQY
SOURce:**VOLT**age:*EQU*alize:**STATe**	**ON** **OFF**		→ Sine signal equalized → Sine signal not dependent on frequency	2.5.4.3 **GEN panel** Equalizer → ON → OFF
MMEMory:**LOAD:***LIST*	*EQU*alize,'**filename**' Query: MMEM:LOAD:LIST? EQU		File containing equalizer data	2.5.4.3 **GEN panel** Equal.File
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 10 V 0 to 20 V 0 to 1 FS	 V V FS	Sine amplitude Analog range (OUTP:TYPE UNB) Analog range (OUTP:TYPE BAL) Digital range "SOUR:VOLT" is voltage-limited by "SOUR:VOLT:LIM" see 3.10.1.2 and 3.10.1.3	2.5.4.3 **GEN panel** VOLTAGE

3.10.1.5.2 MULTISINE

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion [:SHAPe]	***MULT**isine*		Multi-tone (up to 17 sine lines)	2.5.4.4 **GEN panel** FUNCTION → MULTISINE
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed on the generator output. → Virtually no DC voltage component at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low-distortion generator is used.*	2.5.4.1.1 **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<n>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.1.1 **GEN panel** DC Offset
SOURce:***RAND**om:**SPAC**ing:***MODE***	**USER**defined **ATR**ack		Setting the frequency spacing for the multisine measurement → The entered value (see next command) is corrected to the next settable value. → The value of the analyzer frequency spacing of FFT is automatically set It can be read out with command CALC:TRAN:FREQ:RES? provided FFT is selected in the analyzer.	2.5.4.4 **GEN panel** Spacing → USER DEF → ANLR TRACK
SOURce:***RAND**om:**SPAC**ing:**FREQ**uency	**<nu>** Lower limit value: analog = 2.93 Hz digital = sampling frequency / 16384	Hz	Setting value for frequency spacing for multisine measurement The value range depends on the selected generator and its sampling rate (see 2.5.1 Selecting the Generator	2.5.4.4 **GEN panel** Spacing

Command	Parameter	Basic unit	Meaning	Section
SOURce:FUNCtion:MODE alias **SOURce:*MULTisine*:MODE**	***EQU*alvoltage** ***DEF*inedvoltage**		Selection of entry mode for individual multisine voltages: → The same amplitude applies for each sine. It is entered with command SOUR:VOLT1 <nu>. → A separate amplitude can be defined for each sine.	2.5.4.4 **GEN panel** Mode → EQUAL VOLT → DEFINE VOLT
SOURce:VOLTage:*EQU*alizer:STATe	**ON** **OFF**		See 2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM → Every active multisine frequency line is equalized. Equalizer is switched on. The menu item "Equal. file" is activated, ie the indicated file is loaded. → The levels of all frequency lines remain unchanged.	**2.5.4.4** **GEN panel** Equalizer → ON → OFF
MMEMory:LOAD:LIST	***EQU*alizer,'filename'.** Query: MMEM:LOAD:LIST? EQU		Equalizer file for correcting the multisine frequency lines. Only with SOUR:VOLT:EQU:STAT ON selected, see 2.5.4.1.3 Common Parameters for SINE, DFD, MULTI, RANDOM	**2.5.4.4** **GEN panel** Equal.File
SOURce:*MULTisine:COUNt*	**<n>** 1 to 17		Number of settable frequencies	2.5.4.4 **GEN panel** No of Sin
SOURce:VOLTage:CRESTfactor:MODE	***MIN*imized** ***DPH*ase** ***VAL*ue**		→ The crest factor (ratio of peak/rms value) is minimized. → The phase of the lines can be separately set with the next but one command SOURce:PHASe[<i>][:ADJust]. The start phase of the sinewave is entered. → The crest factor is set with the next command SOUR:VOLT:CRES <n> so that it closely approaches a settable value.	2.5.4.4 **GEN panel** Crest Fact → OPTIMIZED → DEFINE PHAS → VALUE
SOURce:VOLTage:CRESTfactor	**<n>** 1 to 100		The specified crest factor is approximated. This is the easier the more lines are used for optimization. Acc. to measurements in line with ANSI S3.42 a crest factor of 4 (= 12 dB) is recommended.	2.5.4.4 **GEN panel** Crest Fact

Command	Parameter	Basic unit	Meaning	Section
SOURce:**PHAS**e[**<i>**][:ADJust]	**<i>** 1 to 17 **<nu>** 0 to 360 °		Entered phase: i-th sine phase; i = 2 to 17 The line is output starting with the specified phase. If 0° is entered, the line starts at 0 and then rises. If 90° is entered, the line starts with the specified voltage and then decreases. For SOUR:VOLT:CRES:MODE DPHase only	2.5.4.4 **GEN panel** Phas No 1 to 17
SOURce:**VOLT**age[**<i>**][:LEVel|AMPLitude]	1 to 17 <nu> Analog instrument OUTP:TYPE UNB 0 to 10 V Analog instrument OUTP:TYPE BAL 0 to 20 V Digital instrument 0 to 1 FS		Level entry for i-th multisine line The maximum amplitude can be set for SOUR<i>:VOLT only when all other sinewaves have an amplitude of 0. Otherwise, V_{max} must be reduced by the sum of the remaining single voltages.	2.5.4.4 **GEN panel** Volt No 1 **to** 17
SOURce:**FREQ**uency[<i>][:CW|FIXed]	**<i>** 1 to 17 **<nu>** Value range determined by instrument or function	Hz	Frequency entry for the i-th multisine line	2.5.4.4 **GEN panel** Freq No 1 to17
SOURce:**VOLT**age:***TOTal:GAIN***	**<nu>**	dB	Subsequent amplification of all sine lines (<0 → attenuation); the upper range limit depends on individual rules for sine and sine frequencies as well as on SOUR:VOLT:LIM	2.5.4.4 **GEN panel** TOTAL GAIN

Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age:***TOTal***[:LEVel|AMPLitude]?	**<nu>** Query only	V FS	Total peak amplitude; query only SOUR:VOLT:TOT is voltage-limited by SCPI command "SOUR:VOLT:LIM" see 3.10.1.2 and 3.10.1.3 With the single amplitudes being unknown, all sinewaves should be set explicitly to 0 before setting the maximum amplitude. 1. SOUR:MULT:MODE EQU 2. SOUR1:VOLT 0	2.5.4.4 **GEN panel** TOTAL PEAK
SOURce:**VOLT**age:***TOTal:RMS?***	**<nu>** Query only	V FS	Total RMS amplitude; query only	2.5.4.4 **GEN panel** TOTAL RMS

3.10.1.5.3 SINE BURST

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion [:SHAPe]	***BURSt***		→ Sine burst	2.5.4.5 **GEN panel** FUNCTION → SINE BURST
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low-distortion generator is used.*	2.5.4.1.1 **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<n>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.1.1 **GEN panel** DC Offset
SOURce:**SWE**ep ...			For sweep commands see 3.10.1.4 Generator Sweeps	
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>** Voltage range determined by instrument or function	Hz	Sine frequency	2.5.4.5 **GEN panel** FREQUENCY
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	 V FS	Burst amplitude (amplitude during HIGH phase of signal) Analog instrument (OUTPUP:TYPE UNB) Analog instrument(OUTP:TYPE BAL) Digital instrument	2.5.4.5 **GEN panel** VOLTAGE
SOURce:**VOLT**age:***LOWL**evel*	**<nu>** 0 to SOUR:VOLT	V %on FS %on	Amplitude during LOW phase of signal Analog instrument Digital instrument	2.5.4.5 **GEN panel** Low Level

Command	Parameter	Basic unit	Meaning	Section
SOURce:***ONTime***[:CW|FIXed]	**<nu>** 0 to 60 s Value range determined by instrument or function	s, cyc	Burst time	2.5.4.5 **GEN panel** ON TIME
SOURce:**INT**erval[:CW|FIXed]	**<nu>** Value range determined by instrument or function	s	Interval time	2.5.4.5 **GEN panel** INTERVAL
SOURce:***ONTime*:**DEL**ay	**<nu>** 0 to 60 s		Sets a start delay for SINE BURST and SINE^2 BURST.	2.5.4.5 2.5.4.6 **GEN panel** BurstOnDel

Note: Clock rate and f_{max} depend on generator (see 2.5.1 Selecting the Generator).

Caution: "SOUR:VOLT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.10.1.5.4 SINE^2 BURST

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion [:SHAPe]	*S2Pulse*		Sine^2 burst	2.5.4.6 **GEN panel** FUNCTION → SINE² BURST
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low-distortion generator is used.*	2.5.4.1.1 **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.1.1 DC Offset
SOURce:**SWE**ep ...			For sweep commands see 3.10.1.4 Generator Sweeps	2.5.4.7 **GEN panel**
SOURce:**FREQ**uency[:CW|FIXed]	**<nu>** Value range determined by instrument or function	Hz	Burst frequency	2.5.4.6 **GEN panel** FREQUENCY
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	V FS	Burst amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument "SOURC:VOLT" is voltage-limited by SCPI command "SOUR:VOLT:LIM" When negative amplitudes are entered the pulse is inverted.	2.5.4.6 **GEN panel** VOLTAGE

Command	Parameter	Basic unit	Meaning	Section
SOURce:***ONT**ime*[:CW|FIXed]	**<nu>** Value range determined by instrument or function	s ,cyc	Burst time	2.5.4.6 **GEN panel** ON TIME
SOURce:***INT**erval*[:CW|FIXed]	**<nu>** Value range determined by instrument or function	s	Interval time	2.5.4.6 **GEN panel** INTERVAL
SOURce:***ONT**ime:**DEL**ay*	**<nu>** 0 to 60 s		Sets a start delay for SINE BURST and SINE^2 BURST.	2.5.4.5 2.5.4.6 **GEN panel** BurstOnDel

3.10.1.5.5 MOD DIST

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion [:SHAPe]	***MDIS****t*		→ Double sine (similar to SMPTE)	2.5.4.7 **GEN panel** FUNCTION → MOD DIST
SOURce:**FREQ**uency:***OFFS****et*:**STATe**	**ON** **OFF**		→ Frequency offset 0.1 % → No frequency offset	2.5.4.1.1 **GEN panel** Frq. Offset → +1000 PPM → OFF
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low-distortion generator is used.*	2.5.4.1.1 **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<n>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.1.1 **GEN panel** DC OFFSET
SOURce:***SIN****usoid*:***DITH****er*:**STATe**	**ON** **OFF**		→ Noise superimposed onto the signal. → Noise superimposition off For digital instrument only	2.5.4.1.1 **GEN panel** Dither → ON → OFF
SOURce:***SIN****usoid*:***DITH****er*	**<nu>** 0 to 1 FS	FS	Noise amplitude	2.5.4.1.1 **GEN panel** Dither

Command	Parameter	Basic unit	Meaning	Section
SOURce:***RAND**om:PDF*	**GAUS**sian **TRI**angle **RECT**angle		→ Noise distribution, Gaussian → Noise distribution, triangular → Noise distribution, equivalent	2.5.4.1.1 **GEN panel** PDF → GAUSS → TRIANGLE → RECTANGLE
SOURce:**LOWD**istortion	**ON** **OFF**		→ Useful signal generated by LDG → Both sines generated by function generator.	2.5.4.1 2.5.4.7 **GEN panel** Low Dist → ON → OFF
SOURce:**SWE**ep ...			For sweep commands see 3.10.1.4 Generator Sweeps	2.5.4.7 **GEN panel**
SOURce:**FREQ**uency[1][:CWIFIXed]	**<nu>** ANALOG gen: 240 Hz ... 21,75 kHz DIGITAL gen: 240 Hz ... f_{max} f_{max} see 2.5.1	Hz	Useful frequency	2.5.4.7 **GEN panel** UPPER FREQ
SOURce:**FREQ**uency**2**[:CWIFIXed]	**<nu>** 30 Hz ... f_{max} / 8 f_{max} see 2.5.1	Hz	Interfering frequency	2.5.4.7 **GEN panel** LOWER FREQ
SOURce:**VOLT**age:***TOTal***[:LEVelIAMPLitude]	**<nu>** Value range determined by instrument or function	V FS	Total amplitude "SOUR:VOLT:TOT" is voltage-limited by SCPI command "SOUR:VOLT:LIM" In the analog instrument the lower limit SOUR:VOLT:RAT (for high rms voltage specifications) depends on the required total rms voltage (see "TOTAL VOLT").	2.5.4.7 **GEN panel** TOTAL VOLT
SOURce:**VOLT**age:***RAT**io*	**<n>** 1 to 10		Ratio of interfering to useful signal	2.5.4.7 **GEN panel** VOLT LF:UF

3.10.1.5.6 DFD

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion [:SHAPe]	*DFD*		→ Double sine (difference frequency method)	2.5.4.8 **GEN panel** FUNCTION → DFD
SOURce:**FREQ**uency:*OFFSet*:**STATe**	**ON** **OFF**		→ Frequency offset 0.1 % → No frequency offset	2.5.4.1 **GEN panel** Frq. Offset → + 1000 PPM → OFF
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low-distortion generator is used. With the offset switched on, the S/N ratio of the analog DFD signal is poorer by 30 dB .*	2.5.4.1 **GEN panel** DC Offset → OFF → ON
SOURce:**FUNC**tion:**MODE**	**IEC**268 **IEC**118		→ Entry of center frequency (MEAN FREQ) and difference frequency (DIFF FREQ) to IEC 268 with commands SOUR:FREQ:MEAN <nu> and SOUR:FREQ:DIFF <nu> If a frequency sweep is selected (for the X or Z axis), the center frequency is swept. → Entry of upper DFD frequency (UPPER FREQ) and difference frequency (DIFF FREQ) to IEC 118 with commands SOUR:FREQ <nu> and SOUR:FREQ:DIFF <nu> If a frequency sweep is selected (for the X or Z axis), the UPPER FREQ is swept.	**2.5.4.1.1** **GEN panel** **Mode** → IEC 268 → IEC 118

Command	Parameter	Basic unit	Meaning	Section
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	<n> -5 V to 5 V -10 V to 10 V -1FS to 1FS	V V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.1.1 **GEN panel** DC OFFSET
SOURce:***SIN**usoid:**DITH**er:**STATe**	**ON** **OFF**		→ Noise is superimposed on signal. → Noise superimposition off For digital instrument only.	2.5.4.1.1 **GEN panel** Dither → ON → OFF
SOURce:***SIN**usoid:**DITH**er*	<nu> 0 to 1 FS	FS	Noise amplitude	2.5.4.1.1 **GEN panel** Dither
SOURce:***RAND**om:**PDF***	**GAUS**sian **TRI**angle **RECT**angle		→ Noise distribution, Gaussian → Noise distribution, triangular → Noise distribution, uniform	2.5.4.1.1 **GEN panel** PDF → GAUSS → TRIANGLE → RECTANGLE
SOURce:**LOWD**istortion	**ON** **OFF**		→ 1st sine generated by LDG → Both sines generated by function generator	2.5.4.1 2.5.4.8 **GEN panel** Low Dist → ON → OFF
SOURce:**SWE**ep ...			For sweep commands see 3.10.1.4 Generator Sweeps	
SOURce:**FREQ**uency:***MEAN***	<nu> Value range determined by instrument or function	Hz	Center frequency	2.5.4.8 **GEN panel** MEAN FREQ

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FREQ**uency:[1][:CW|FIXed]	**<nu>** Value range determined by instrument or function		Entry of upper DFD frequency with SOURce:FUNCtion:MODE IEC 118 selected.	**2.5.4.8 GEN-panel** UPPER FREQ
SOURce:**FREQ**uency:***DIFF**erence*	**<nu>** Value range determined by instrument or function	Hz	Difference frequency	2.5.4.8 **GEN panel** DIFF FREQ
SOURce:**VOLT**age:***TOTal***[:LEVel|AMPLitude]	**<nu>** Value range determined by instrument or function	V FS	Total amplitude	2.5.4.8 **GEN panel** TOTAL VOLT

Note: Clock rate, f_{min}, f_{max} depend on generator (see 2.5.1 Selecting the Generator)

Caution: "SOUR:VOLT:TOT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.10.1.5.7 RANDOM

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion [:SHAPe]	**RAND**om		→ Noise	2.5.4.9 **GEN panel** FUNCTION →RANDOM
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low-distortion generator is used.*	2.5.4.1.1 **GEN panel** DC Offset →OFF →ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<n>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.1.1 **GEN panel** DC OFFSET
SOURce:***RAND**om:**DOM**ain*	***FREQ**uency* ***TIME***		→ Frequency domain → Time domain	2.5.4.9 **GEN panel** Domain → FREQ → TIME
SOURce:**VOLT**age:***TOTal***[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	V FS	Noise peak amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument "SOUR:VOLT:TOT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"	2.5.4.9 **GEN panel** VOLT PEAK
SOURce:**VOLT**age:***TOTal:RMS?***	**<nu>** Query only	V FS	Queries the noise RMS amplitude	2.5.4.9 **GEN panel** VOLT RMS

Further commands for frequency domain only (SOUR:RAND:DOM FREQ):

Command	Parameter	Basic unit	Meaning	Section
SOURce:*RANDom:SPACing:*MODE	*ATRack* *USERdefined*		→ Analyzer frequency spacing synchronous → Frequency spacing acc. to user entry	2.5.4.9 **GEN panel** Spacing → ANLR TRACK → USER DEF
SOURce:*RANDom:SPACing:FREQuency*	**<nu>** Value range determined by instrument or function	Hz	Entry of frequency spacing	2.5.4.9 **GEN panel** Spacing
SOURce:*RANDom:SHAPe*	*WHITe* *PINK* *TOCTave* *ARBitrary*		→ White noise → Pink noise → 1/3-octave noise → File-defined noise	2.5.4.9 **GEN panel** Equalizatn → WHITE → PINK → THIRD OCT → FILE
SOURce:*RANDom:FREQuency:LOWer* SOURce:*RANDom:FREQuency:UPPer*	**<nu>** Value range determined by instrument or function	Hz	Lower/upper frequency limit for white and pink noise	2.5.4.9 **GEN panel** Lower Freq Upper Freq
SOURce:FREQuency:*MEAN*	**<nu>** Value range determined by instrument or function	Hz	Center frequency for 1/3-octave noise	2.5.4.9 **GEN panel** MEAM FREQ

Command	Parameter	Basic unit	Meaning	Section
MMEMory:**LOAD:*LIST***	***ARB**itrary*, **'filename'** Query: MMEM:LOAD:LIST? ARB ***RAND**om*, **'filename'** Query: MMEM:LOAD:LIST? RAND		File with data for file-defined noise. ARBitrary and RANDom are synonyms.	2.5.4.9 **GEN panel** Shape File

Further commands for time domain only (SOUR:RAND:DOM TIME):

Command	Parameter	Basic unit	Meaning	Section
SOURce:***RAND**om:PDF***	***GAUS**sian* ***TRI**angle* ***RECT**angle*		→ Noise distribution, Gaussian → Noise distribution, triangular → Noise distribution, uniform	2.5.4.9 **GEN panel** PDF → GAUSS → TRIANGLE → RECTANGLE

3.10.1.5.8 ARBITRARY

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion [:SHAPe]	**USER**		→ User-defined waveforms	2.5.4.10 **GEN panel** FUNCTION → ARBITRARY
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low-distortion generator is used.*	2.5.4.1.1 **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	<n> -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.1.1 **GEN panel** DC Offset
MMEMory:**LOAD:*LIST***	***ARB**itrary*, **'filename'** Query: MMEM:LOAD:LIST? ARB		File with data for waveform	2.5.4.10 **GEN panel** Filename

Command	Parameter	Basic unit	Meaning	Section
SOURce:**VOLT**age:***TOTal***[:LEVel|AMPLitude]	**<nu>** **Analog Instrument:** Output = UNBAL: 0 ... 14,142 V (OUTPUT = BAL: 0 ...16.971 V **Digital Instrument:** Src Mode = AUDIO DATA: 0 ... 1 FS Src Mode = JITTER ONLY: 0 UI ... 2,5 UI Src Mode = PHASE: 0 ... 1 FS Src Mode = COMMON ONLY: 0 V ... 10 V	V FS	Peak amplitude of signal SOUR:VOLT:TOT and SOUR:VOLT:TOT:RMS are coupled via the crest factor (which is constant for a specific signal). A change of SOUR:VOLT:TOT therefore immediately affects the figure for SOUR:VOLT:TOT:RMS. If the crest factor is changed, SOUR:VOLT:TOT will remain unchanged. "SOUR:VOLT:TOT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"	2.5.4.10 **GEN panel** VOLT PEAK
SOURce:**VOLT**age:***TOTal:RMS***	**<nu>** 0 V ... 20 V	V FS	RMS signal amplitude for Analog generator SOUR:VOLT:TOT and SOUR:VOLT:TOT:RMS are coupled via the crest factor (which is constant for a specific noise signal). A change of SOUR:VOLT:TOT:RMS therefore affects the SOUR:VOLT:TOT value.	2.5.4.10 **GEN panel** VOLT RMS

3.10.1.5.9 POLARITY

Command	Parameter	Basic unit	Meaning	Section
SOURce:**FUNC**tion [:SHAPe]	*POLarity*		→ Polarity test signal	2.5.4.11 **GEN panel** FUNCTION → POLARITY
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**OFF** **ON**		DC offset permitting a DC voltage to be superimposed at the generator output. → Hardly any DC voltage at the output → DC voltage can be set with the next command. ***Note:*** *This setting cannot be made in the analog generator when a low-distortion generator is used.*	2.5.4.1.1 **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<n>** -5 V to 5 V -10 V to 10 V -1FS to 1FS	V FS	DC amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	2.5.4.1.1 **GEN panel** DC Offset
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 20 V 0 to 1 FS	V FS	Pulse amplitude Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument "SOURC:VOLT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"	2.5.4.11 **GEN panel** VOLTAGE

3.10.1.5.10 FSK (Frequency shift keying)

Command	Parameter		Meaning	Section
SOURce:**FUNC**tion[:SHAPe]	**FSK**		Frequency shift keying; generates a sequence of two different sinewave frequencies each being output for 9 ms (baud rate 110) . The data coded in this way can only be defined from option UPL-33 or UPL-B10 using command SOURce:O33 'O33-' . Frequency #1: 1850 Hz, logic 0 Frequency #2: 1650 Hz, logic 1	**2.5.4.12** **GEN panel** FUNCTION → FSK
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et:**STATe**	**ON** **OFF**		DC offset allows a DC voltage to be superimposed onto the generator output. → Almost no DC voltage at the output → The DC component can be set with the following command. ***Note**:* *This setting is not possible in the analog generator when the low-distortion generator is used.*	**2.5.4.12** **GEN panel** DC Offset → OFF → ON
SOURce:VOLTage[:LEVel|AMPLitude]:**OFFS**et	**<nu>** -5 V to 5 V -10 V to 10 V -1FS to 1FS		Amplitude of DC component Analog instrument (OUTP:TYPE UNB) Analog instrument (OUTP:TYPE BAL) Digital instrument	**2.5.4.12** **GEN panel** DC Offset
SOURce:**VOLT**age	<nu> 0 to 11.29 V 0 FS to 1 FS		Level for both FSK frequencies	**2.5.4.12** **GEN panel** Volt No 1
SOURce:**O33**	'O33 ID code		Sends the code for line measurements. The data coded in this way can only be sent from option UPL-B33 or UPL-B10 (universal sequence controller).	**No manual operation**

3.10.2 IEC/IEEE-Bus Commands for Analyzers

3.10.2.1 Selection of Analyzer

Command	Parameter	Basic unit	Meaning	Section
INSTrument**2**[:SELect] equivalent to **INST**rument**2**:**NSEL**ect	**A22** **A110** **D48** **1** **2** **4**		→ Analog analyzer, 22 kHz → Analog analyzer, 110 kHz → Digital analyzer, 48 kHz → Analog analyzer, 22 kHz → Analog analyzer, 110 kHz → Digital analyzer, 48 kHz	2.6.1 **ANLR panel** INSTRUMENT → ANLG 22 kHz → ANLG 110 kHz → DIGITAL

3.10.2.2 Configuration of Analog Analyzers

Command	Parameter	Basic unit	Meaning	Section
INPut[]:**FILT**er[:LPASs]:**FREQ**uency	**<nu>** Query only 2 Hz I 10 Hz	Hz	Lower limit frequency for analyzer instruments A22 and D48.	2.6.2 **ANLR panel** Min Freq
SENSe[]:**POW**er:**REF**erence:***RES**istance*	**<nu>** 1 mΩ to 100 kΩ	Ohm	Reference resistance for power units	2.4 (RREF) 2.6.2 **ANLR panel** Ref Imped

Command	Parameter	Basic unit	Meaning	Section
INPut[]:***SEL**ect*	***CH1*** ***CH2*** ***CH1A**nd2* ***CH1I**s2* ***CH2I**s1*		→ Only channel 1 active → Only channel 2 active → Channel 1 and 2 active, settings may be different → Channel 1 and 2 active, identical settings Data of channel 1 adopted for channel 2. → Channel 1 and 2 active, identical settings Data of channel 2 adopted for channel 1.	2.6.2 **ANLR panel** CHANNEL(s) →1 →2 →1 & 2 →1 ≡ 2 →2 ≡ 1
INPut[1|2]:**COUP**ling	**AC** **DC**		Selection of coupling of analyzer input circuit for channels 1 and 2: available in the two analog analyzer instruments only (INST2 A22 I 100). → AC coupling A DC offset of the DUT will not be transmitted and does not therefore affect the DUT. ***Note:*** *A procedure similar to AC coupling can be selected in the digital analyzer for specific measurement functions. Selection is made with menu item DC Suppres ON (SENS:FUNC:DCS ON).* → DC coupling: Test signals up to 0 Hz are picked up and considered in the results of RMS, RMS selective, Peak, Quasi-peak, DC, FFT and Waveform measurements.	**2.6.2** **ANLR panel** CH1 Coupl CH2 Coupl → AC → DC
INPut[1|2]:***TYPE***	***BAL**anced* ***GEN1*** ***GEN2***		→ Balanced input (XLR connector), see Fig. 2-1/7. For analog instruments only. → Internal connection to generator channel 1. For analog instruments only. → Internal connection to generator channel 2. For analog instruments only.	2.6.2 **ANLR panel** Input → BAL XLR → GEN1 → GEN2 → GEN CROSSED
INPut[1|2]:**IMP**edance	***R300*** ***R600*** ***R200K***		Input impedance for unbalanced input → 300 Ω → 600 Ω → 200 kΩ	2.6.2 **ANLR panel** Imped → 300 Ω → 600 Ω → 200 Ω

Command	Parameter	Basic unit	Meaning	Section
INPut[1|2]:**LOW**	**FLO**at **GRO**und		→ Outer conductor of unbalanced. input not connected to instrument ground (PE conductor). → Outer conductor of unbalanced. input connected to instrument ground (PE conductor)	2.6.2 **ANLR panel** Common → FLOAT → GROUND
SENSe[]:**VOLT**age:**RANG**e[1|2]:**LOW**er	**<nu>** For value range see 2.6.2 Configuration of the Analog Analyzers	V	Sets a range containing the specified level value. No underrange but higher ranges may be selected.	2.6.2 **ANLR panel** Range →LOWER
SENSe[]:**VOLT**age:**RANG**e[1|2]:**AUTO**	**ON** **OFF**		→ Autoranging → The current range is accepted and retained as :UPPer. Corresponds to SENSe[]:VOLTage:RANGe[1|2][:UPPer]<current range>	2.6.22.6.2 **ANLR panel** Range →AUTO
SENSe[]:**VOLT**age:**RANG**e[1|2][:UPPer]	**<nu>** For value range see 2.6.2 Configuration of the Analog Analyzers	V	Sets a range containing the specified level value and holds it unconditionally.	2.6.2 **ANLR panel** Range →FIX

3.10.2.3 Configuration of Digital Analyzers

Command	Parameter	Basic unit	Meaning	Section
SENSe:DIGital:FEED	***ADATa*** ***JPHase*** ***CINPut***		Specifies the parameter measured in the analyzer: → Audio content → Demodulated jitter signal in the frequency range 0 to 100 kHz → Common-mode signal of digital inputs measured. Frequency range and measurement function same as with jitter.	2.6.3.1 **ANLR panel** Meas Mode → AUDIO DATA → JITTER/PHAS → COMMON/INP
SENSe:DIGital:SYNC:REFerence	***GCLock*** ***PLLVari*** ***PLL32*** ***PLL44*** ***PLL48***		→ The generator clock is the reference for the jitter measurement. → Reference signal is the sampling signal derived from the input signal via the internal synchronization PLL. Synchronization is made via the VCO with maximum lock-in range. → Reference signal is the sampling signal derived from the → input signal via the internal synchronization PLL. Synchronization is made via → the fixed-frequency VCXO. Only for SENS:DIG:FEED JPH	2.6.3 **ANLR-Panel**Related to →GEN CLK → VARI (PLL) → 32.0 (PLL) → 44.1 (PLL) → 48.0 (PLL)
INPut:FILTer[:LPASs]:FREQuency	<n> Query only **10** Hz **I 20** Hz	Hz	Lower frequency limit of analyzer. For SENS:DIG:FEED ADAT only.	2.6.1 **ANLR panel** Min Freq
INPut[]:*SELect*	***CH1*** ***CH2*** ***BOTH***		For SENS:DIG:FEED ADAT only → Only channel 1 active → Only channel 2 active → Channel 1 and 2 active, identical setting	2.6.2 2.6.3 **ANLR panel** CHANNEL(s) →1 →2 →BOTH
INPut[1|2]:*TYPE*	***AESebu*** ***SPDif*** ***OPTical*** ***INTern***		→ AES/EBU interface, for connector see Fig. 2-1/10.[FW2] → S/P DIFF interface, for connector see Fig. 2-1/10. → Optical interface, for connector see Fig. 2-1/10. → Internal interface for digital generator OPTical and INTern for SENS:DIG:FEED ADATIPHAS only.	2.6.3 **ANLR panel** Input → BAL (XLR) → UNBAL (XLR) → OPTICAL → INTERN

Command	Parameter	Basic unit	Meaning	Section
SENSe:**DIG**ital:**SYNC**:**SOUR**ce	***AINP**ut* ***RINP**ut*		→ The receiver is clocked with the input signal (for SENS:DIG:FEED ADATIPHAS only). → The receiver is clocked with the signal at the reference input (for SENS:DIG:FEED ADATIJPH only).	2.6.3 **ANLR panel** Sync To → AUDIO IN → REF IN
INPut[]:***SAMP**le:**FREQ**uency:**MODE***	***F32*** ***F44*** ***F48*** ***VAL**ue* ***AUTO*** ***CHST**atus*		→ Sampling frequency for digital instrument, 32 kHz → Sampling frequency for digital instrument, 44.1 kHz → Sampling frequency for digital instrument, 48 kHz → Sampling frequency externally applied. For input values see next command. → Transfer of measured sample frequency. The sample rate is updated if the value varies by more than 0.01%. Smaller variations are ignored. → Transfer of the sample frequency specified in the channel status data. For SENS:DIG:FEED ADATIPHAS only.	2.6.3 **ANLR panel** Sample Frq → 32 kHz → 44.1 kHz → 48 kHz → VALUE: → AUTO → CHAN STATUS
INPut[]:***SAMP**le:**FREQ**uency*	**<nu>** 100 Hz to 52.5 kHz	Hz	Value of applied sampling frequency For SENS:DIG:FEED ADATIPHAS only	2.6.3 **ANLR panel** Sample Frq → VALUE:
INPut[]:***AUD**iobits*	**<n>** For value range see 2.6.3 Configuration of the Digital Analyzer		Word length of audio samples to be analyzed in bits. For SENS:DIG:FEED ADATIPHAS only	2.6.3 **ANLR panel** Audio Bits

3.10.2.4 Starting the Analyzer, Ext. Sweep

Command	Parameter	Basic unit	Meaning	Section
TRIGger:**SOUR**ce	**IMM**ediate **TIM**er **CH1**Freq|**CH2**Freq **CH1**Level |**CH2**Level **CH1**Trigger|**CH2**Trigg er **TCH**art **CH1**Rapidfreq **CH2**Rapidfreq **CH1**Edgetrigger **CH2**Edgetrigger		→ Continuous measurement mode w i t h o u t trigger condition → Storing measured values in the buffer at regular intervals. → Collection of measured values due to a variation in frequency found at the ANALYZER input, channel 1 or channel 2. → Collection of measured values due to a variation in level found at the ANALYZER input, channel 1 or channel 2. → Triggers a single measurement as soon as the level is within the range specified by ARM:VOLT:STAR and ARM:VOLT:STOP. → Measured values from the ongoing continuous measurement are entered into a timing diagram at the time interval selected by means of command TRIG:TIM **<nu>**. → External frequency sweep with fast frequency measurement in channel 1 → and channel 2 → Edge-sensitive triggering; a measurement is triggered as soon as the level → enters the interval between ARM:VOLT:START and ARM:VOLT:STOP **for the first time**.	2.6.4 **ANLR panel** START COND →AUTO →TIME →CH1Freq | CH2Freq →CH1Level | CH2Level →LEV TRG CH1| LEV TRG CH2 →TIME CHART → FRQ FST CH1 → FRQ FST CH2 → EDG TRG CH1 → EDG TRG CH2
TRIGger:**DEL**ay	**<nu>** 0 s to 10 s	s	Waiting time after the measurement (settling time for DUT).	2.6.4 **ANLR panel** Delay
TRIGger:**TIM**er	**<nu>** 10 ms to 2000 s	s	Interval between recordings of measured values.	2.6.4 **ANLR panel** Timetick
TRIGger:**COUN**t	**<n>** 2 to 1024		Number of measured values entered into the buffer.	2.6.4 **ANLR panel** Points
ARM:**LEV**el:**MIN**	**<nu>** Analog instruments 10 µV to 1000 V Digital instrument 1µFS to 1.0 FS	V FS	Minimum voltage required for triggering a measurement with external frequency sweep.	2.6.4 **ANLR panel** Min VOLT

Command	Parameter	Basic unit	Meaning	Section
ARM:**FREQ**uency:**STAR**t **ARM:FREQ**uency:**STOP**	**<nu>** Value range determined by instrument or function	Hz	The input frequency must be within the start/stop frequency for triggering the measurement.	2.6.4 **ANLR panel** Start | Stop
ARM:VOLTage:**STAR**t **ARM:VOLT**age:**STOP**	**<nu>** Analog instruments 10 µV to 1000 V Digital instrument 1 µFS to 1.0 FS	V FS	The input level must be within the start/stop voltage limits for triggering a measurement.	2.6.4 **ANLR panel** Start | Stop
TRIGger:**FREQ**uency:**VAR**iation	**<nu>** 0.1 to 50%	PTC	Minimum percentage by which the input frequency must vary for triggering a measurement.	2.6.4 **ANLR panel** Variation
TRIGger:**VOLT**age:**VAR**iation	**<nu>** 0.1 to 50%	PTC	Minimum percentage by which the input voltage must vary for triggering a measurement.	2.6.4 **ANLR panel** Variation

3.10.2.5 Analyzer Functions

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	*'**OFF**'* *'**RMS**'* *'**RMSS**electiv'* *'**PEAK**'* *'**QREak**'* *'**DC**'* *'**THD**'* *'**THDN**sndr'* *'**MDIS**t'* *'**DFD**'* *'**WAF**'* *'**POL**arity'* *'**FFT**'* *'**FILT**ersimulation'* *'**WAV**eform'* *'**PROT**ocol'* *'**PHAS**etoref'* *'**DIGI**npamp'* *'**THIR**doct'*		→ Function measurement off → RMS measurement ' → RMS selective measurement → Peak measurement → Quasi-peak measurement → DC measurement → THD measurement → THD+N measurement → MOD DIST measurement → DFD measurement → Wow & flutter measurement → Polarity measurement → FFT display → Filter simulation → Waveform display → AES/EBU protocol → Measurement of phase between digital input and reference input → Measurement of digital input amplitude → Third analysis	**2.6.5** **ANLR panel** FUNCTION

3.10.2.5.1 Common Parameters for Analyzer Functions

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**TRIG**ger:**SETT**ling:**MODE** **SENS**e[1]:**FUNC**tion:**SETT**ling:**MODE** **SENS**e3:**FREQ**uency:**SETT**ling:**MODE** **SENS**e3:**PHAS**e:**SETT**ling:**MODE**	**OFF** **EXP**onential **FLAT** **AVER**age		SENS:TRIG:SETT = Settling process for external triggering SENS:FUNC:SETT = Settling process for measurement function SENS3:FREQ:SETT = Settling process for frequency measurement SENS3:PHAS:SETT = Settling process for phase measurement → OFF → Settling with exponential tolerance and resolution characteristic → Settling with tolerance and resolution band → Arithmetic averaging (not for settling with external triggering)	2.6.5.1 **ANLR panel** Settling → OFF → EXPONENTIAL → FLAT → AVERAGE
SENSe[1]:**TRIG**ger:**SETT**ling:**COUN**t **SENS**e[1]:**FUNC**tion:**SETT**ling:**COUN**t **SENS**e3:**FREQ**uency:**SETT**ling:**COUN**t **SENS**e3:**PHAS**e:**SETT**ling:**COUN**t	**<n>** for EXP I FLAT: 2 to 6 for AVER: 2 to 100		Number of test points considered in settling. 3 means that the currently measured value is compared with the two preceding results.	2.6.5.1 **ANLR panel** Samples
SENSe[1]:**TRIG**ger:**SETT**ling:**TOL**erance **SENS**e[1]:**FUNC**tion:**SETT**ling:**TOL**erance **SENS**e3:**FREQ**uency:**SETT**ling:**TOL**erance	**<n>** 0.001 to 10 %	%	Starting value of exponential tolerance characteristic or tolerance band.	2.6.5.1 **ANLR panel** Tolerance
SENSe[1]:**TRIG**ger:**SETT**ling:**RES**olution **SENS**e[1]:**FUNC**tion:**SETT**ling:**RES**olution **SENS**e3:**FREQ**uency:**SETT**ling:**RES**olution **SENS**e3:**PHAS**e:**SETT**ling:**RES**olution	**<nu>** Value range and units are determined by instrument and function see 2.6.5.1	V FS % dB Hz DEG(°)	Starting value of exponential resolution characteristic or resolution band.	2.6.5.1 **ANLR panel** Resolution
SENSe[1]:**FUNC**tion:**SETT**ling:**TOUT** **SENS**e3:**FREQ**uency:**SETT**ling:**TOUT** **SENS**e3:**PHAS**e:**SETT**ling:**TOUT**	**<nu>** 0.001 to 10 s	s	Maximum settling time If no settled measurement result is achieved within this time, the measurement is aborted and an invalid result is signalled.	2.6.5.1 **ANLR panel** Timeout

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**SPE**aker:**SOUR**ce	**OFF** **INP1** **INP2** **IN1A**nd2 **FNC1** **FNC2** **FN1A**nd2 **AES1** **AES2** **AE1A**nd2		→ Loudspeaker and headphones output switched off. → Aural monitoring of input signal of analog analyzers A22 and A110 on channel 1. The signal is available at both output channels. In the DIGITAL analyzer with option Digital Audio I/O (UPL-B2) in the **Meas Mode JITTER/PHAS** the demodulated jitter signal is applied to the ANLG 110 kHz analyzer and can be listened to. In the DIGITAL analyzer with option Digital Audio I/O (UPL-B2), in the **Meas Mode COMMON/INP** the superimposed common-mode signal is applied to the digital inputs of the ANLG 110 kHz analyzer and can be monitored. → The input signal of the analog analyzer A22 and A110 can be monitored on channel 2. → ... on both channels (stereo). With channel 1 or 2 selected as analyzer input, only the left or, the right headphones output can be used for monitoring. → Aural monitoring of function output of analog analyzer A22 for all measurement functions (except THD+N) for channel 1. → ... for channel 2. → ... for both channels (stereo). → Aural monitoring of left channel of AES/EBU interface of digital analyzer D48 (Option: Digital Audio Protocol Analysis and Generation UPL-B2). → ... of right channel ... → ... of both channels (stereo) ...	2.6.6 **ANLR panel** SPEAKER → OFF → INPUT Ch1 → INPUT JITT → INPUT COMM → INPUT Ch2 → INPUT Ch1&2 → FUNCT Ch1 → FUNCT Ch2 → FUNCT Ch1&2 → DIG Ch1 → DIG Ch2 → DIG Ch1&2
SYSTem:**SPE**aker:**GAIN**	**<nu>** -120 to 120 dB	dB	Amplification or attenuation of function output.	2.6.6 **ANLR panel** Pre Gain
SYSTem:**SPE**aker:**VOL**ume	**<nu>** 0 to 100 %	%	Volume of monitor output	2.6.6 **ANLR panel** Skp Volume

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**PHON**e	**SPKC** **PERM**		→ Phones output conforms to loudspeaker setting. → Headphones output permanently switched on.	2.6.6 **ANLR panel** Phone Out → SPKPhone → PERMANENT
SYSTem:**SPE**aker[:STATe]	**ON** **OFF**		→ Loudspeaker on → Loudspeaker off Command has no effect if option UPL-B5 is not fitted.	2.6.6 **ANLR panel** LOCAL key

3.10.2.5.2 RMS Measurement incl. S/N

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	*"RMS"*		→ RMS measurement	**2.6.5** **ANLR panel** FUNCTION → RMS & S/N
SENSe[1]:**FUNC**tion:**DCS**uppression	**ON** **OFF**		Suppression of DUT DC in the digital analyzer. → DC not considered; corresponds to AC coupling → DC considered in the measurement and displayed; corresponds to DC coupling	**2.6.5.1** **ANLR panel** DC Suppres → ON → OFF
SENSe[1]:**FUNC**tion:***SNS**equence*	**ON** **OFF**		→ S/N (signal-to-noise) measurement on → S/N (signal- to-noise) measurement off	2.6.5.1 **ANLR panel** S/N Sequ
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	see 3.10.4		Display units for RMS measurement	2.4 **ANLR panel** Unit Ch1/CH2

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**VOLTage:APERture:MODE**	*AFASt* *AUTO* *TRIGgered* *VALue*		AFASt and AUTO match the measurement time to the signal frequency by taking the signal period into account. The measurement time is matched as far as possible to the input signal. Maximum algorithmic error: → 1% → 1‰. → A special mode is available for **RMS measurements,** permitting a single **delay-free** measurement with selectable measurement time to be carried out as soon as the signal exceeds a set trigger threshold for the first time. In conjunction with the generator burst signal this measurement mode permits the first period of a signal to be measured and is particularly suitable for echo-free measurements on loudspeakers. → Numerical entry of measurement time. For entry of values see next command.	2.6.5.2 **ANLR panel** Meas Time → AUTO FAST → AUTO → TRIGGERED → VALUE:
SENSe[1]:**VOLTage:APERture**	**<nu>** 1 ms ... For value range see 2.6.5.2 → Meas Time	s	Numerical entry of measurement time. Measurement time for steadying the display.	2.6.5.2 **ANLR panel** Meas Time
SENSe[1][:VOLTage|POWer]:**REFerence:MODE**	*CH1Store* *CH2Store* *CH1Meas* *CH2Meas* *STORe* *VALue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured in channel 1 is used as a reference for the output of results in reference-related units. → The value measured in channel 2 is used as a reference for the output of results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The reference value is entered using the next command.	2.6.5.1 **ANLR panel** Reference
SENSe[1][:VOLTage|POWer]:**REFerence**	**<nu>** Analog instrument 100 pV to 1000 V Digital instrument 0.0 to 1.0 FS	V FS	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Reference

Command	Parameter	Basic unit	Meaning	Section
SENSe:SWEep:SYNC	**NORMal** **BLOCk**		Permits the speed to be increased for 1-dimensional generator frequency sweeps with the universal generator: → normal speed common for all sweeps → sweep speed increased after the 2nd sweep; traces are not updated online but only upon completion of the sweep (all at once).	**2.6.5.1** **ANLR panel** Sweep Mode → NORMAL → BLOCK
SENSe[1]:***NOTCh***[:STATe]	**OFF** **DB0** **DB12** **DB30**		→ Analog notch filter off; → Analog notch filter on; no gain → Analog notch filter on; gain 12 dB → Analog notch filter on; gain 30 dB	2.6.5.1 **ANLR panel** Anlg. Notch → OFF → 0 dB → 12 dB → 30 dB
SENSe[1]:***NOTCh:FREQuency:MODE***	***FIXed*** ***GENTrack***		→ For numerical entry of notch-filter center frequency see next command. → The notch-filter center frequency tracks the generator frequency.	2.6.5.1 **ANLR panel** Notch Freq → VALUE: → GEN TRACK
SENSe[1]:***NOTCh:FREQuency:FIXed***	**<nu>** for analog instr. 10 Hz to 22.5 kHz	HZ	Numerical center frequency of notch filter. For analog instrument only.	2.6.5.1 **ANLR panel** Notch Freq → VALUE:
SENSe[1]:**FILTer**<i>:.....	<i> 1 to 3		See 3.10.3 Selecting the Analyzer Filters	2.7.1 **ANLR panel** Filter

Command	Parameter	Basic unit	Meaning	Section
CALCulate:**TRAN**sform:**FREQ**uency:**STATe**	**OFF** **ON**		→ No POST-FFT for the selected measurement function → POST-FFT for selected measurement function: see 2.6.5.12 FFT with the following settings available: CALCulate:TRANsform:FREQuency:FFT S256 to S8K CALCulate:TRANsform:FREQuency:WINDow RECT to KAIS CALCulate:TRANsform:FREQuency:STARt ? CALCulate:TRANsform:FREQuency:STOP ? CALCulate:TRANsform:FREQuency:RESolution? If the group-delay measurement is selected with command SENSe3:FUNCtion FQGRoupdelay, POST-FFT is always active as the frequency information is obtained from FFT.	2.6.5.1 **ANLR panel** POST FFT → OFF → ON
SENSe[1]:**TRIGger**:**SETTling**:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Fnct Settl

3.10.2.5.3 Selective RMS Measurement incl. Sweep

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"***RMSS****electiv*"		Selective RMS measurement	**2.6.5** **ANLR panel** FUNCTION → RMS SELECT
SENSe[1]:**FUNC**tion:**DCS**uppression	**ON** **OFF**		Suppression of DUT DC in the digital analyzer. → DC not considered; corresponds to AC coupling → DC considered in the measurement and displayed; corresponds to DC coupling	**2.6.5.1** **ANLR panel** DC Suppres → ON → OFF
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	see 3.10.4 Units for IEC Measurement Results		Display units for RMS measurement	2.4 **ANLR panel** Unit Ch1/CH2
SENSe[1]:**VOLT**age:**APER**ture:**MODE**	***AFASt*** ***AUTO*** ***VAL****ue*		AFASt and AUTO: Automatic matching of measurement time to the signal frequency taking the signal period into account. The measurement time is matched as far as possible to the input signal. Maximum algorithmic error → 1%, → 1‰. → Numerical entry of measurement time. For entry of values see next command.	2.6.5.3 **ANLR panel** Meas Time → AUTO FAST → AUTO → VALUE
SENSe[1]:**VOLT**age:**APER**ture	**<nu>** 10 µs to 10s	s	Numerical entry of measurement time. Measurement time for steadying the display.	2.6.5.3 **ANLR panel** Meas Time

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**BWID**th[**:RES**olution]:**MODE** equivalent to **SENS**e[1]:**BAND**width[**:RES**olution]:**MODE**	*PPCT1* *PPCT3* *PTOCt* *POCT12* *PFIX* *PFASt* *SPCT1* *SPCT3* *STOCt* *SOCT12* *SFIX* *SFASt*		Bandwidth of bandpass or bandstop of selective RMS filter. Parameter starting with P ... = bandpass S ... = bandstop **PFASt** **SFASt:** Bandstop filter with only 40 dB attenuation, third-octave bandwidth and particularly short settling time.	2.6.5.3 **ANLR panel** Bandwidth → BP 1% → BP 3 % → BP 1/3 OCT → BP 1/12 OCT → BP FIX: → **BP FAST** → BS 1% → BS 3 % → BS 1/3 OCT → BS 1/12 OCT → BS FIX: → **BS FAST**
SENSe[1]:**BWID**th[**:RES**olution] equivalent to **SENS**e[1]:**BAND**width[**:RES**olution]	<nu> Value range determined by instrument or function	Hz	Numerical entry of arithmetically symmetrical bandwidth.	2.6.5.3 **ANLR panel** Bandwidth
SENSe[1][:VOLTage|POWer]:**REF**erence:**MODE**	*CH1Store* *CH2Store* *CH1Meas* *CH2Meas* *STORe* *GENTrack* *VALue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured in channel 1 is used as a reference for the output of results in reference-related units. → The value measured in channel 2 is used as a reference for the output of results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The currently set generator output level is used as a reference. Using the subsequent command SENS:FREQ:FACT <n> the bandpass filter of the RMS SEL measurement in the Freq Mode GENTRACK can be set to any multiple of the fundamental. This allows single harmonics to be measured. → The reference value is entered using the next command.	2.6.5.1 **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:

Command	Parameter	Basic unit	Meaning	Section
SENSe[1][:VOLTage|POWer]:**REF**erence	<nu> Analog instruments 100 pV to 1000 V Digital instrument 0.0 to 1.0 FS	V FS	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Reference

Sweep for selective RMS measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FREQ**uency:**MODE**	**FIX**ed|**CW**		→ Presetting for fixed frequency of selective RMS measurement. Numerical entry with SENSe[1]:FREQuency[:FIXed|:CW]**<nu>**	2.6.5.3 **ANLR panel** SWEEP CTRL → OFF → AUTO SWEEP MANU SWEEP → AUTO LIST MANU LIST →GEN MLTSINE FREQ MODE → GEN TRACK → FREQ CH1 → FREQ CH2
	SWEep		→ Frequency sweep of selective RMS measurement. The sweep parameters are determined by the following user specifications: SENSe[1]:FREQuency:STARt|STOP **<nu>** SENSe[1]:SWEep:SPACing LINear|LOGarithmic SENSe[1]:SWEep:STEP **<nu>** SENSe[1]:SWEep:POINts <n>	
	LIST		→ List sweep of frequency of selective RMS measurement. The sweep parameters are read from the file specified under MMEMory:LOAD:LIST FREQuency, "filename" For format of block/list files see 2.9.1.3 Format of Block/Listen Data.	
	***MUL**Tisine*		→ The frequency of the selective RMS measurement is set consecutively to the multisine frequencies specified in the generator panel (see 2.5.4.4 MULTISINE). The sweep is similar to a LIST sweep.	
	***GENT**rack*		→ The frequency of the selective RMS measurement tracks the current generator frequency. By means of the factor (see next command SENS:FREQ:FACT <n>) it can be determined whether the center frequency should directly track the generator frequency (factor = 1) or be a multiple thereof. If the factor is an integral multiple, it may be used for measuring single harmonics. The bandpass center frequency can be tracked to the generator signal functions SINE, MULTISINE, BURST or SINE2 PULSE", only; any other signal function causes an error message.	
	CH1 ***CH2***		The frequency of the selective RMS measurement tracks the frequency measured in → channel 1 → channel 2.	
SENSe:**FREQ**uency:**FACT**or	**<nu>** MLT 1 to 20 for RMS selective measurements		Factor by which the tracking bandpass filter is higher than the generator frequency with setting GENTRACK (SENS:FREQ:MODE GENT).	**2.6.5.3** **ANLR panel** FREQ MODE → Factor

Command	Parameter	Basic unit	Meaning	Section
SENSe:SWEep:SYNC	**NORMal** **FAST** **BLOCk**		Permits the speed of 1-dimensional sweeps with the universal generator to be increased. → Normal speed used for any kind of sweep → Sweep speed increased as from 2nd sweep → Sweep speed increased again as from 2nd sweep; update of curve not online but only upon completion of the sweep (all at once).	**2.6.5.3** **ANLR panel** Sweep Mode → NORMAL → FAST → BLOCK
SENSe[1]:***NOTCh***[:STATe]	**DB12** **DB30** **DB0** **OFF**		→ Analog notch filter on; gain 12 dB → Analog notch filter on; gain 30 dB → Analog notch filter on; no gain → Analog notch filter off. The notch filter can only be set in the analog instruments when a bandstop filter has been selected for SENS:BWID:MODE.	2.6.5.1 **ANLR panel** Anlg. Notch → 12 dB Auto → 30 dB Auto → 0 dB → OFF
SENSe[1]:**FILTer2**:.....			See 3.10.3 Selecting the Analyzer Filters Particularly when monitoring weak residual signals amplified by means of Pre Gain, a highpass filter should be used for DC suppression to avoid the signal to be distorted or suppressed altogether. In conjunction with a selective RMS measurement **filter No. 2 must** be selected as filter No. 1 is already used in the UPL as a selective RMS bandpass or bandstop filter. 3.10.3 Selecting the Analyzer Filters	2.7.1 **ANLR panel** Filter
SENSe[1]:**FREQuency**[:FIXedICW]	**<nu>** Value range determined by instrument or function	Hz	Numerical entry of frequency for selective RMS measurement.	2.6.5.3 **ANLR panel** FREQ MODE → FIX
SENSe[1]:**SWEep:MODE**	**AUTO** **MANual**		Automatic sweep → This command in conjunction with command SENSe[1]:FREQuency:MODe SWEep sets the AUTO SWEEP mode. → This command in conjunction with command SENSe[1]:FREQuency:MODe SWEep sets the MANU SWEEP mode. Pressing the LOCAL key activates the spinwheel.	2.6.5.3 **ANLR panel** SWEEP CTRL → AUTO SWEEP → MANU SWEEP

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**LIST**:**MODE**	**AUTO** **MAN**ual		Automatic list sweep → This command in conjunction with command SENSe[1]:FREQuency:MODe LIST sets the AUTO LIST mode. → This command in conjunction with command SENSe[1]:FREQuency:MODe SWEep sets the MANU LIST mode. Pressing the LOCAL key activates the spinwheel.	2.6.5.3 **ANLR panel** SWEEP CTRL → AUTO LIST → MANU LIST
SENSe[1]:**FREQ**uency:**STAR**t **SENS**e[1]:**FREQ**uency:**STOP**	**<nu>** Value range determined by instrument or function	Hz	Start and stop frequency for frequency sweep of selective RMS measurement.	2.6.5.3 **ANLR panel** SWEEP CTRL → Start | Stop
SENSe[1]:**SWE**ep:**SPAC**ing	**LIN**ear **LOG**arithmic		→ Linear sweep spacing → Logarithmic sweep spacing	2.6.5.3 **ANLR panel** Spacing → LIN → LOG
SENSe[1]:**SWE**ep:**POIN**ts	**<n>** 2 to 1024		Number of sweep steps. Depending on the selected SPACing (SENSe[1]:SWEep:SPACing LINear|LOGarithmic), the sweep frequency range between "STARt" and "STOP" is divided into <n> linear or logarithmic sweep points.	2.6.5.3 **ANLR panel** Points
SENSe[1]:**SWE**ep:**STEP**	**<nu>** | **<n>** The selected step size should be so wide that not more than 1023 single steps (= 1024 sweep points) are obtained. It should not exceed the absolute difference between STOP and STARt.	→	Sweep step size Depending on selected SPACing SENSe[1]:SWEep:SPACing LINear|LOGarithmic, the sweep frequency range between "STARt" and "STOP" is divided into linear steps in Hz or logarithmic steps in the form of a multiplier. SENSe[1]:SWEep:SPACing LINear: Hz SENSe[1]:SWEep:SPACing LOGarithmic: No unit because of multiplication factor.	2.6.5.3 **ANLR panel** Steps

Command	Parameter	Basic unit	Meaning	Section
MMEMory:**LOAD:*LIST***	**FREQ**ency,"**filename**" = path and filename of frequency list for a LIST sweep of a selective RMS measurement, eg "c:\UPL\ref\swpflst.lst"		Loading a frequency list for the list sweep.	2.6.5.3 2.9.1.3 **ANLR panel** SWEEP CTRL →Filename
SENSe[1]:**FUNC**tion:**SETT**ling:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Fnct Settl

3.10.2.5.4 Peak and Quasi-Peak Measurement incl. S/N

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"*PEAK*"		→ Peak measurement	**2.6.5** **ANLR panel** FUNCTION →PEAK & S/N
SENSe[1]:**FUNC**tion	"*QPEak*"		→ Quasi-peak measurement	**2.6.5** **ANLR panel** FUNCTION →QPK & S/N
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	see 3.10.4 Units for IEC Measurement Results		Display units for RMS measurement	2.4 **ANLR panel** Unit Ch1/CH2
SENSe[1]:**FUNC**tion:***SNS**equence*	**ON** **OFF**		→ S/N (signal-to-noise) measurement on. → S/N (signal-to-noise) measurement off.	2.6.5.1 **ANLR panel** S/N Sequ → ON → OFF
SENSe[1]:**FUNC**tion:***MMOD**e*	***PPE**ak* ***NPE**ak* ***PTOP**eak* ***PABS**olut*		→ PK+ value → PK- value → Peak-to-peak value → Absolute peak value	2.6.5.4 **ANLR panel** Meas Mode → PK + → PK - → PK to PK → PK abs

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**VOLT**age:***INTV***time:**MODE**	***SFAS***t ***FAST*** ***SLOW*** ***FIX***ed ***VAL***ue		→ 50 ms → 200 ms monitoring interval for **peak** search → 1000 ms → s monitoring interval for **quasi-peak** search → Numerical entry of interval time. For entry of values see next command.	2.6.5.4 **ANLR panel** Intv Time → FIX 50ms → FIX 200ms → FIX 1000ms → FIX 3 SEC → VALUE:
SENSe[1]:**VOLT**age:***INTV***time**	**<nu>** 20 ms to 10s	s	Numerical entry of interval time. Monitoring interval for peak search	2.6.5.4 **ANLR panel** Intv Time
SENSe[1][:VOLTage|POWer]:**REF**erence:**MODE**	***CH1S***tore ***CH2S***tore ***CH1M***eas ***CH2M***eas ***STOR***e ***GENT***rack ***VAL***ue		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the results in reference-related units. → The value measured of channel 2 is used as a reference for the results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The currently set generator output level is used as a reference. → The reference value is entered using the next command.	2.6.5.1 **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:
SENSe[1][:VOLTage|POWer]:**REF**erence	**<nu>** Analog instrument 100 pV to 1000V Digital instrument 0.0 to 1.0 FS	V FS	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Reference

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:***NOTCh***[:STATe]	**DB0** **DB12** **DB30** **OFF**		→ Analog notch filter on; no gain → Analog notch filter on; gain 12 dB → Analog notch filter on; gain 30 dB → Analog notch filter off;	2.6.5.1 **ANLR panel** Anlg. Notch → 0 dB → 12 dB → 30 dB → OFF
SENSe[1]:***NOTCh:FREQ***uency:***MODE***	*FIXed* *GENTrack*		→ For numerical entry of notch-filter center frequency see next command. → The center frequency of the notch filter tracks the generator frequency.	2.6.5.1 **ANLR panel** Notch Freq → VALUE: → GEN TRACK
SENSe[1]:***NOTCh:FREQ***uency:***FIX***ed	**<nu>** for analog instr. 10 Hz to 22.5 kHz	Hz	Numerical center frequency of notch filter.	2.6.5.1 **ANLR panel** Notch Freq → VALUE:
SENSe[1]:**FILT**er<i>:.....	<i> 1 to 3		See 3.10.3 Selecting the Analyzer Filters	2.7.1 **ANLR panel** Filter
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Fnct Settl

3.10.2.5.5 DC Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	*"DC"*		→ DC measurement	**2.6.5** **ANLR panel** FUNCTION → DC
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	see 3.10.4 Units for IEC Measurement Results		Display units for RMS measurement	2.4 **ANLR panel** Unit Ch1/CH2
SENSe[1]:**VOLT**age:**APER**ture:**MODE**	***FAST*** ***VAL**ue*		→ 200 ms integration time for steadying the display. → Numerical entry of integration time. For entry of values see next command.	2.6.5.5 **ANLR panel** Meas Time → FIX 200ms → VALUE:
SENSe[1][:VOLTage|POWer]:**REF**erence:***MODE***	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***STOR**e* ***GENT**rack* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the results in reference-related units. → The value measured of channel 2 is used as a reference for the results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The currently set generator output level is used as a reference. → The reference unit is specified by the next command.	2.6.5.1 **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:
SENSe[1][:VOLTage|POWer]:**REF**erence	**<nu>** Analog instrument - 1000 V to 1000 V	V	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Reference
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Fnct Settl

3.10.2.5.6 THD Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"*THD*"		THD measurement	**2.6.5** **ANLR panel** FUNCTION →THD
SENSe[1]:**FUNC**tion:***MMOD***e	***SEL***ectdi ***LSEL***ectdi ***DALL*** ***LDALl*** ***DODD*** ***LDODd*** ***DEV***en ***LDEV***en		→ Any combination of harmonics from d2 to d9 can be set with the → following command. Result in dB Result in V (analog) or FS (digital) → Selection of harmonics to be measured: → All harmonics from d2 to d9 Result in dB Result in V (analog) or FS (digital) → All uneven harmonics: → d3, d5, d7, d9 Result in dB Result in V (analog) or FS (digital) → All even harmonics: → d2, d4, d6, d8 Result in dB Result in V (analog) or FS (digital)	2.6.5.6 **ANLR panel** Meas Mode →SELECT di → LEV SEL di → All di → LEV All di → All odd di → LEV odd di → All even di → LEV even di
SENSe[1]:**FUNC**tion:***DIST***ortion	<n> *)		Decimal equivalent of integer <n> for any combination of harmonics, eg d2, d4, d6, d9, is desired; binary: 10010101; decimal equivalent <n> = 149	2.6.5.6 **ANLR panel** → di2468
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision		→ Analog notch switched off. → Analog notch switched on when the applied signal is of good quality.	2.6.5.6 **ANLR panel** Dyn Mode → FAST → PRECISION
SENSe[1]:**UNIT**	**PCT|DB**		Display units for results of THD measurements.	2.4 **ANLR panel** Unit

Command	Parameter	Basic unit	Meaning	Section
SENSE[1][:VOLTage|POWer]**:REF**erence	<nu> Analog Instruments: 100 pV ... 1000 V Digital Instrument: 100 pFS ... 100 FS	V FS	Numerical entry of reference value in reference-related level units. SENS:FUNC:MMOD LSEL | LDAL | LDOD | LDEV	2.6.5.1 **ANLR panel** Ref Volt
SENSe[1]:**VOLT**age:***FUND**amental*:**MODE**	***AUTO*** ***VAL**ue*		Determining the fundamental frequency: Automatically by frequency measurement. Numerical entry of fundamental frequency. For entry of values see next command.	2.6.5.6 **ANLR panel** Fundamentl
SENSe[1]:**VOLT**age:***FUND**amental*	<nu> Value range determined by instrument or function	Hz	Numerical entry	2.6.5.6 **ANLR panel** Fundamentl
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling command see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Fnct Settl

*)

MSB							LSB	Data bit
di9	di8	di7	di6	di5	di4	di3	di2	Harmonics
128	64	32	16	8	4	2	1	Weighting

Example: di1, di3, di5 and di7
Data word: 10101010
Weighting = 2+8+32+128
Decimal equivalent: =170

3.10.2.5.7 THD + N / Sinad Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"*THDN*sndr"		→ THD+N measurement	**2.6.5** **ANLR panel** FUNCTION →THD+N/SINAD
SENSe[1]:**FUNC**tion:***MMOD***e	***THDN*** ***LTHD****n* ***SNDR****atio* ***NOIS****e* ***LNO****ise*		Result display as → THD+N value in dB → THD+N RMS value in V (analog) or FS (digital) → SINAD value in negative dB → Same as THD+N but without harmonics weighting, in dB → Same as THD+N RMS value but without harmonics weighting, in V (analog) or FS (digital)	2.6.5.7 **ANLR panel** Meas Mode →THD+N → LEVEL THD+N → SINAD → NOISE → LEVEL NOISE
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision		→ Analog notch filter switched off. → Analog notch filter switched on when the applied signal is of good quality.	2.6.5.7 **ANLR panel** Dyn Mode → FAST → PRECISION
SENSe:**FUNC**tion:**APER**ture:**MODE**	**SLOW** **FAST** **SFAS**t		Selection of measurement speed → Measurement using FFT size 8192 → Measurement using FFT size 2048 → Measurement using FFT size 512	**2.6.5.7** **ANLR panel** Meas Time → SLOW → FAST → SUPERFAST
SENSe[1]:***THDN*:*REJ****ection***	***NARR****ow* ***WIDE***		Sets the characteristic of the notch filter in the digital instrument. → The noise is measured close to the carrier. → An two-pole notch filter is additionally taken into account to evaluate attenuated harmonics in the vicinity of the carrier.	2.6.5.7 **ANLR panel** Rejection → NARROW → WIDE
SENSe[1]:**UNIT**	**PCT**|**DB**		Display units for results of THD+N measurement	2.4 **ANLR panel** Unit

Command	Parameter	Basic unit	Meaning	Section
SENSe[1][:VOLTage|POWer]:**REF**erence	**<nu>** Analog Instruments: 100 pV ... 1000 V Digital Instrument: 100 pFS ... 100 FS	V FS	Numerical entry of reference value for measurement response in reference-related level units for the setting SENS:FUNC:MMOD LTHD | LNO	**2.6.5.1** **ANLR-Panel** Ref Volt
SENSe[1]:**VOLT**age:***FUND**amental*:***MODE***	***AUTO*** ***VAL**ue*		Determining the fundamental frequency: → Automatically by frequency measurement. → Numerical entry of fundamental frequency. For entry of values see next command.	2.6.5.7 **ANLR panel** Fundamentl → AUTO → VALUE:
SENSe[1]:**VOLT**age:***FUND**amental*	**<nu>** Value range determined by instrument or function	Hz	Numerical entry of fundamental frequency	2.6.5.7 **ANLR panel** Fundamentl
SENSe[1]:**FILT**er1:.....			See 3.10.3 Selecting the Analyzer Filters	2.7.1 **ANLR panel** Fnct Settl
CALCulate:**TRAN**sform:**FREQ**uency:**STATe**	**OFF** **ON**		→ No POST-FFT for the selected measurement function → POST-FFT for selected measurement function (see 3.10.2.4.12 FFT) CALC:TRAN:FREQ:FT S256 to S8K CALC:TRAN:FREQ:WIND RECT to KAIS CALC:TRAN:FREQ:STAR? CALC:TRAN:FREQ:STOP? CALCe:TRAN:FREQ:RES?	2.6.5.1 **ANLR panel** POST FFT → OFF → ON
CALCulate:**TRAN**sform:**FREQ**uency:***FFT***	***S512*** ***S1K*** ***S2K*** ***S4K*** ***S8K***		FFT Size → 512 lines → 1024 lines → 2048 lines → 4096 lines → 8192 lines	**2.6.5.12** **ANLR-Panel** FFT Size → 512 → 1024 → 2048 → 4096 → 8192

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FREQ**uency:***LIMit:UPPer***	**<nu>** Value range determined by instrument or function	Hz	Upper band limit for THD+N measurement function	2.6.5.7 **ANLR panel** → Frq Lim Upp
SENSe[1]:**FREQ**uency:***LIMit:LOWer***	**<nu>** Value range determined by instrument or function	Hz	Lower band limit for THD+N measurement function	2.6.5.7 **ANLR panel** → Frq Lim Low
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.7.1 **ANLR panel** Fnct Settl

3.10.2.5.8 MOD DIST

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"*MDIST*"		MOD-DIST measurement. Measurement with double-sine (similar to SMPTE)	**2.6.5** **ANLR panel** FUNCTION → MODDIST
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision		→ Analog notch filter switched off. → Analog notch filter switched on if the applied signal is of good quality.	2.6.5.8 **ANLR panel** Dyn Mode → FAST → PRECISION
SENSe[1]:**UNIT**	**PCT|DB**		Display units for results of MOD-DIST measurement.	2.4 **ANLR panel** Unit
SENSe[1]:**FUNC**tion:**SETTl**ing:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Fnct Settl

3.10.2.5.9 DFD

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	*"DFD"*		→ Difference frequency distortion measurement	**2.6.5** **ANLR panel** FUNCTION → DFD
SENSe[1]:**UNIT**	**PCT|DB**		Display units for results of DFD measurement	2.4 **ANLR panel** Unit
SENSe[1]:**FUNC**tion:***MMOD**e*	***D2*** ***D3***		→ Intermodulation distortion d2 → Intermodulation distortion d3	2.6.5.9 **ANLR panel** Meas Mode → d2 (IEC268) → d3 (IEC268) → d2 (IEC118) → d3 (IEC118)
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision		→ Analog notch filter switched off. → Analog notch filter switched on if the applied signal is of good quality.	2.6.5.9 **ANLR panel** Dyn Mode → FAST → PRECISION
SENSe[1]:**FUNC**tion:**SETT**ling:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Fnct Settl

3.10.2.5.10 Wow & Flutter

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	*"WAF"*		→ Wow & flutter measurement	**2.6.5** **ANLR panel** FUNCTION → WOW & FL
SENSe[1]:**FUNC**tion:***STAN**dard*	***NAB*** ***JIS*** ***DIN**iec* ***SI05*** ***SI10***		→ W&F acc. to NAB → W&F acc. to JIS → W&F acc. to DIN/IEC → W&F, 2-sigma, 5 s. → W&F, 2-sigma, 10 s	2.6.5.10 **ANLR panel** Rule → NAB → JIS → DIN/IEC → 2 Sigma 5 s → 2 Sigma 10s
SENSe[1]:**FUNC**tion:***WEIG**hting*	***ON*** ***OFF***		→ W&F weighting filter on → W&F weighting filter off	2.6.5.10 **ANLR panel** Weighting → ON → OFF
SENSe[1]:**UNIT**	**PCT**		No further display unit selectable.	2.4 **ANLR panel** Unit
CALCulate:**TRAN**sform:**FREQ**uency:**STATe**	**OFF** **ON**		→ No POST-FFT for selected measurement function → POST-FFT for selected measurement function (see 3.10.2.4.12 FFT) CALC:TRAN:FREQ:FFT S256 to S8K CALC:TRAN:FREQ:WIND RECT to KAIS CALC:TRAN:FREQ:STAR? CALC:TRAN:FREQ:STOP? CALC:TRAN:FREQ:RES?	2.6.5.1 **ANLR panel** POST FFT → OFF → ON
SENSe[1]:**FUNC**tion:**SETT**ling:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Fnct Settl

3.10.2.5.11 POLARITY

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"*POLarity*"		→ Polarity test of DUT.	**2.6.5** **ANLR panel** FUNCTION → POLARITY

3.10.2.5.12 FFT

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"*FFT*"		→ FFT measurement function	2.6.5.12 **ANLR panel** Function → FFT
SENSe[1]:**FUNC**tion:**DCS**uppression	**ON** **OFF**		Suppression of DUT DC in the digital analyzer. → DC not considered; corresponds to AC coupling → DC considered in the measurement and displayed; corresponds to DC coupling	**2.6.5.1** **ANLR panel** DC Suppres → ON → OFF
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	see 3.10.4 Units for IEC Measurement Results		Display units for RMS measurement	2.4 **ANLR panel** Unit Ch1/CH2

Command	Parameter	Basic unit	Meaning	Section
SENSe[1][:VOLTage|POWer]:**REF**erence:**MODE**	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***STOR**e* ***GENT**rack* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the output of results in reference-related units. → The value measured of channel 2 is used as a reference for the output of results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The currently set generator output level is used as a reference. → The reference value is entered using the next command.	2.6.5.1 **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:
SENSe[1][:VOLTage|POWer]:**REF**erence	**<nu>** Value range determined by instrument or function	V FS	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Reference
SENSe[1]:**CHAN**nel:**DEL**ay	**<nu>** -10 ... 10 s	s	Interchannel delay Delay compensation of the DUT by entering the time by which channel 1 is to be delayed with respect to channel 2. If channel 2 has a shorter delay than channel 1, this can be compensated for by entering a negative value. Available only for for two-channel measurements in instruments A22 and D48 and Zoom FFT off ("CALC:TRAN:FREQ:ZOOM 1")	**2.6.5.12** **ANLR-Panel** Chan Delay
SENSe[1]:***NOTCh***[:STATe]	**DB12** **DB30** **DB0** **OFF**		→ Analog notch filter on; gain 12 dB → Analog notch filter on; gain 30 dB → Analog notch filter on; no gain → Analog notch filter off;	2.6.5.1 **ANLR panel** Anlg. Notch → 0 dB → 12 dB → 30 dB → OFF

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:***NOTCh*:*FREQ***uency**:**MODE**	*FIXed* *GENTrack*		→ For numerical entry of notch-filter center frequency see next command. → Center frequency of notch filter tracks the generator frequency.	2.6.5.1 **ANLR panel** Notch Freq → VALUE: → GEN TRACK
SENSe[1]:***NOTCh*:*FREQ***uency**:***FIX***ed**	**<nu>** Value range determined by instrument or function	HZ	Numerical entry of notch-filter center frequency.	2.6.5.1 **ANLR panel** Notch Freq → VALUE:
CALCulate:**TRAN**sform:**FREQ**uency:***FFT***	***S256*** ***S512*** ***S1K*** ***S2K*** ***S4K*** ***S8K***		FFT size → 256 lines → 512 lines → 1024 lines → 2048 lines → 4096 lines → 8192 lines	2.6.5.12 **ANLR panel** FFT Size → 256 → 512 → 1024 → 2048 → 4096 → 8192
CALCulate:**TRAN**sform:**FREQ**uency: ***AVER**age*	**<n>** 1 to 256		Number of averaging procedures for optimum noise suppression.	2.6.5.12 **ANLR panel** Average
CALCulate:**TRAN**sform:**FREQ**uency:**AVER**age:**TCON**trol	**NORM**al **EXP**onential		→ The specified number of FFTs is performed, intermediate results are added and then divided by this number. → Averaging is performed continuously.	2.6.5.12 **ANLR panel** Avg Mode → NORMAL → EXPONENTIAL
CALCulate:**TRAN**sform:**FREQ**uency:**STAR**t? **CALC**ulate:**TRAN**sform:**FREQ**uency:**STOP**?	**<nu>** Query only		Queries the beginning and end of FFT, depending on CENTer and SPAN. The response is **<nu>** in Hz.	2.6.5.12 **ANLR panel** Start / Stop

Command	Parameter	Basic unit	Meaning	Section
CALCulate:**TRAN**sform:**FREQ**uency:**CENT**er	<nu> Value range determined by instrument or function	Hz	Center frequency for FFT calculation	2.6.5.12 **ANLR panel** Center
CALCulate:**TRAN**sform:**FREQ**uency:***ZOOM***	<n> = 1 **1 to 128** for instr. A22 a. D48 n = 1, 2, 4, 8, 16, 32, 64, 128 A110 = n =1, 2, 4, 8,16		Zoom FFT off (standard FFT) FFT zoom factor Contrary to the manual mode, the zoom factor instead of the SPAN is entered in the IEC/IEEE-bus mode. The SPAN being a function of the zoom factor it can be determined by the following query.	2.6.5.12 **ANLR panel** Zoom-FFT
CALCulate:**TRAN**sform:**FREQ**uency:**SPAN?**	<nu> Query only		Queries the frequency range around the center frequency as a function of the zoom factor. The response is <nu> in Hz. Contrary to the manual mode, SPAN can only be read in but not entered in the IEC/IEEE-bus mode. The SPAN value can be changed by changing the zoom factor and modifying the sampling frequency and the oversampling factor.	2.6.5.12 **ANLR panel** Span
CALCulate:**TRAN**sform:**FREQ**uency:***RES**olution***?	<nu> Query only		Queries the frequency resolution of FFT, depending on CENTer and SPAN. The response is <nu> in Hz.	2.6.5.12 **ANLR panel** Resolution
CALCulate:**TRAN**sform:**FREQ**uency:***MTIM**e***?	<nu> Query only		Queries the measurement time of FFT, depending on FFT size. The response is <nu> in s.	2.6.5.12 **ANLR panel** Meas Time

Command	Parameter	Basic unit	Meaning	Section
CALCulate:**TRAN**sform:**FREQ**uency:**WIND**ow	**RECT**angular **HANN**ing ***BLAC**kman_harris* ***RIF1*** ***RIF2*** ***RIF3*** **HAMM**ing **FLAT**top ***KAIS**er*		→ Fast and frequency-accurate → High spectral resolution, wide, bell-shaped curve → Steep slope of bell lobe → Excellent suppression of distant interference → Excellent suppression of distant interference → Excellent suppression of distant interference → Implemented for the sake of completeness → Amplitude read from graphic diagram → Characteristics determined by ß factor	2.6.5.12 **ANLR panel** Window → RECTANG... → HANN → BLACKMAN H → RIFE VINC 1 → RIFE VINC 2 → RIFE VINC 3 → HAMMING → FLAT TOP → KAISER
CALCulate:**TRAN**sform:**FREQ**uency:**WIND**ow:***BETA**factor*	<n> = 1 to 20	keine Einheit	ß factor for KAISer window	2.6.5.12 **ANLR panel** ß-Factor

3.10.2.5.13 Filter Simulation

Command	Parameter	Basic unit-	Meaning	Section
SENSe[1]:**FUNC**tion	**'FILT**ersim'		→ Display of sum frequency response of the filter to be selected with SENS:FILT... on the UPL display, eg SENS:FILT:AWE ON SESN:FILT2:UFIL5 ON SENS:FUNC 'FILT' IEC LAD 20 IEC GTL	2.6.5.13 ANLR panel Function → FILTER SIM.
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	**PCT** **DB** see 3.10.4 Units for IEC Measurement Results		Unit of Y axis to be selected with the next command for display of the filter curve.	2.4 ANLR panel Unit Ch1/Ch2
SENSe[1]:**FILT**er<i>:.....	<i> 1 to 3		See 3.10.3 Selecting the Analyzer Filters	2.7.1 ANLR panel Filter

3.10.2.5.14 WAVEFORM

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	"**WAV**eform"		→ Waveform display of applied signal	**2.6.5** **ANLR panel** Function → WAVEFORM
SENSe[1]:**FUNC**tion:**DCS**uppression	**ON** **OFF**		Suppression of DUT DC in the digital analyzer. → DC not considered; corresponds to AC coupling → DC considered in the measurement and displayed; corresponds to DC coupling	**2.6.5.1** **ANLR panel** DC Suppres → ON → OFF
SENSe[1]:**FUNC**tion:***MMOD**e*	***STAN**dard* ***COMP**ressed* ***USAM**pl*		→ Standard display of samples, max. trace length is 7488 samples. Interpolation can be switched on. → To allow measurements over longer periods of time only peaks are displayed. With command SENSe:WAVeform:COMPression <n> (see below) the number of peak-weighted samples is determined. Available only for instruments A22 and D48. Interpolation cannot be switched on. → Undersampling of signal to record longer periods; the number of samples specified under SENSe:WAVeform:COMPression is arithmetically combined (without detection).	2.6.5.14 **ANLR panel** Meas Mode → STANDARD → COMPRESSED → UNDERSAMP
SENSe[1]:***WAV**eform:**COMP**ression*	**<n>** 2 to 1024		Number of peak-weighted samples of WAVeform mode SENSe:FUNCtion:MMODe COMPressed.	2.6.5.14 **ANLR panel** Comp Fact
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	see 3.10.4 Units for IEC Measurement Results		Display unit for results of DC measurement.	2.4 **ANLR panel** Unit
SENSE[1][:VOLTage|POWer]:**REF**erence	**<nu>** Analog instrument - 1000 V to 1000 V Digital instrument - 1 kFS to 1 kFS	V FS	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Reference

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er<i>:.....	<i> 1		See 3.10.3 Selecting the Analyzer Filters A filter each can be selected in analyzers ANLG 22 kHz and DIGITAL (INST2 A22ID48) in the Source Mode AUDIO DATA (SENS:DIG:FEED ADAT) for the measurement function WAVEFORM in the Meas Mode UNDERSAMPLE (SENS:FUNC:MMOD USAM).	**2.6.5.14** **ANLR-Panel** Filter
TRIGger:**LEV**el	**<nu>** Analog instruments -50V to 50V Digital instrument -1 FS to 1 FS	V FS	Sets the voltage for the trigger threshold.	2.6.5.14 **ANLR panel** Trig Level
TRIGger:**SLOP**e	**POS**itive alias **RIS**ing **NEG**ative alias **FALL**ing		Sets the trigger edge.	2.6.5.14 **ANLR panel** Trig Slope → RISING → FALLING
SENSe[1]:**SMO**othing:**APER**ture	**N1** **N2** **N4** **N8** **N16** **N32**		Selects the interpolation stages for smoothing the display of the traced waveform. N1 to N32 = factor 1 to 32	2.6.5.14 **ANLR panel** Interpol → 1 → 2 → 4 → 8 → 16 → 32
SENSe[1]:***WAV**eform:**DUR**ation*	**<nu>** see 2.6.5.14 WAVEFORM	s	Sets the period for which the signal is traced. The max. settable Trace Len is a function of the sampling rate and the interpolation value.	2.6.5.14 **ANLR panel** Trace Len

Command	Parameter	Basic unit	Meaning	Section
TRIGger:CHANnel	*CH1* *CH2* *GENBurst*		→ Channel 1 → Channel 2 ...triggers the measurement for both channels when the trigger level is exceeded (TRIGger:LEVel **<nu>**). → The generator signal triggers the measurement upon start of the "Burst On" phase, provided that a suitable generator function has been selected. Signal delay times of the devices under test can thus be determined graphically from the waveform display. To be set only for two-channel measurements in instruments A22 and D48.	2.6.5.14 **ANLR panel** Trig Src → CHAN 1 → CHAN 2 → GEN BURST

3.10.2.5.15 Coherence Measurement and Transfer Function

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	'COHerence'		Coherence and transfer function with built-in option UPL-B6 Conditions: • Analog instrument 22 kHz (INST2 A22) or digital instrument (INST2 D48) in Meas Mode AUDIO DATA (SENS:DIG:FEED ADAT) • Two-channel measurement (INP:SEL CH1A | CH2ICH1I | BOTH)	**2.6.5.22** **ANLR panel** FUNCTION → COHERENCE
SENSe[1][:VOLTage|POWer]:**UNIT**[1]	**PCT** **DB**		Units for result display for transfer function (ratio channel 2/channel 1) of COHERENCE measurement provided TRACE A is selected with DISP:TRAC:FEED 'SENS:DATA'.	**2.6.5.22** **ANLR panel** Unit Ch1
SENSe[1]:**CHAN**nel:**DEL**ay	<nu> -10 ... 10 s	s	Interchannel delay Delay compensation of the DUT by entering the time by which channel 1 is to be delayed with respect to channel 2. If channel 2 has a shorter delay than channel 1, this can be compensated for by entering a negative value. Available only for for two-channel measurements in instruments A22 and D48	**2.6.5.22** **ANLR-Panel** Chan Delay
CALCulate:**TRAN**sform:**FREQ**uency: *FFT*	*S256* *S512* *S1K* *S2K* *S4K* *S8K*		FFT size → 256 lines → 512 lines → 1024 lines → 2048 lines → 4096 lines → 8192 lines	**2.6.5.22** **ANLR panel** FFT Size → 256 → 512 → 1024 → 2048 → 4096 → 8192

Command	Parameter	Basic unit	Meaning	Section
CALCulate:**TRAN**sform:**FREQ**uency: **WIND**ow	**HANN**ing **RECT**angular ***BLAC**kman_harris* ***RIF1*** ***RIF2*** ***RIF3*** **HAMM**ing **FLAT**top ***KAIS**er*		→ Fast and frequency-accurate → Selective, wide bell → Steep bell slopes → Excellent far-off band attenuation → Excellent far-off band attenuation → Excellent far-off band attenuation → For reason of completeness → Amplitude can be read off the graphics display → Characteristics determinable by ß factor (subsequent command)	**2.6.5.22** **ANLR panel** Window → HANN → RECTANG... → BLACKMAN H → RIFE VINC 1 → RIFE VINC 2 → RIFE VINC 3 → HAMMING → FLAT TOP → KAISER
CALCulate:**TRAN**sform:**FREQ**uency:**WIND**ow:***BETA**factor*	<n> 1 to 20		ß-factor for KAISer window	**2.6.5.22** **ANLR panel** ß factor
CALCulate:**TRAN**sform:**FREQ**uency: ***AVER**age*	<n> 2 to 2048		Number of averaging procedures to increase the accuracy of the coherence measurement	**2.6.5.22** **ANLR panel** Average

3.10.2.5.16 Loudspeaker Measurements (RUB & BUZZ)

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	**'RUBB**uzz'		Loudspeaker measurements only with built-in option UPL-B6 The Rub&Buzz measurement is available in the 22 kHz analog instrument (INST2 A22) for the two channels, in the 110 kHz instrument (INST2 A100) for channel 1 only (INP:SEL CH1).	**2.6.5.23** **ANLR panel** FUNCTION → RUB & BUZZ
SENSe[1]:**VOLT**age:**APER**ture:**MODE**	**AFAS**t **AUTO** **VAL**ue **GENT**rack		Measurement time of RUB & BUZZ measurement for adapting the measurement speed to the signal frequency. → Automatic matching of measurement time to signal frequency taking into account the → signal period. → Numerical entry of desired measurement time. → Measurement taking up (at least) one whole generator signal period. If required, the generator frequency can be adapted to the analyzer sample rate. To increase the measurement time in the case of high frequencies, the measurement time is exceeded to several periods. This mode guarantees **maximum accuracy** at a **minimum measurement time** and **should be given preference.**	**2.6.5.23** **ANLR panel** Meas Time → AUTO FAST → AUTO → VALUE: → GEN TRACK
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	**V** | **DBV** | **DBU** | ... | **DBR**		Unit for result display of RUB & BUZZ measurement	**2.6.5.23** **ANLR panel** Unit Ch1/CH2
SENSe[1][:VOLTage|POWer]:**REF**erence:**MODE**	***VAL**ue* ***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***STOR**e*		→ Reference value to be entered with the following command → With two-channel measurements the current measurement result of channel 1 is stored as reference value. → With two-channel measurements the current measurement result of channel 2 is stored as reference value. → Value measured in channel 1 is used as a reference for result display with relative units → Value measured in channel 2 is used as a reference for result display with relative units. → With single-channel measurements the current result is stored as reference value.	**2.6.5.23** **ANLR panel** Reference

Command	Parameter	Basic unit	Meaning	Section
SENSe[**1**][:VOLTage|POWer]:**REF**erence	<nu> Analog instrument 100 pV to 1000 V		Numerical entry of reference value with command SENS:REF:MODE VAL	**2.6.5.23** **ANLR panel** Reference
SENSe[1]:**FREQ**uency:**MODE**	**FIX**ed | **CW** ***GENT**rack*		Determination of highpass filter type → A fixed highpass filter is used; the numeric value of the passband frequency is entered with the subsequent command SENS:FREQ <nu>. → Generator tracking: A tracking highpass filter is used which should preferably be tuned to about the 5th harmonic of the generator frequency. The multiple by which the passband frequency should be higher than the generator frequency can be entered with the subsequent command SENS:FREQ:FACT <n>. Frequency limits, within which tracking of the filter frequency should be performed, can be selected with commands SENSe[1]:FREQuency:LIMit:LOWer and SENSe[1]:FREQuency:LIMit:UPPer. When a limit is reached (FrqLim Low or Upp) the filter frequency is held at this frequency. Thus a tracking highpass filter can be created which becomes a fixed-frequency highpass filter below FrqLim Low and/or above FrqLim Upp. If tracking should be performed over the entire frequency range, the frequency limits should be set to the minimum and maximum value.	**2.6.5.23** **ANLR panel** FREQ MODE → FIX → GEN TRACK
SENSe[1]:**FREQ**uency[:FIXed|CW]	<nu> Value range depends on instrument		Entry of numeric passband frequency for the setting SENS:FREQ:MODE FIX	**2.6.5.23** **ANLR panel** FREQ MODE → FIX
SENSe:**FREQ**uency:**FACT**or	<nu> MLT 2 to 20		Factor by which the passband frequency of the tracking bandpass or highpass filter should be higher than the generator frequency when GENTRACK (SENS:FREQ:MODE GENT) is set.	**2.6.5.23** **ANLR panel** FREQ MODE → Factor

Command	Parameter	Basic unit	Meaning	Section
SENSe:SWEep:SYNC	**NORMal** **FAST** **BLOCk**		Permits the speed for 1-dimensional sweeps with the universal generator to be increased: → Normal sweep speed to be used with any kind of sweeps. → Sweep speed increased as from 2nd sweep run. → Further increase of sweep speed as from 2nd sweep. Update of trace is not online but performed (all in one) when the sweep is completed.	**2.6.5.23** **ANLR panel** Sweep Mode → NORMAL → FAST → BLOCK
SENSe[1]:FILTer2:..... ↑ └ **The 2 is important!**			A (digital) filter can be selected in addition to the standard highpass filter. **Use**: Lowpass filter for band limiting (particularly in the ANLG 110 kHz instrument), delay filter for extending the settling time, etc. ***Note***: *Like the standard highpass filter, the filter selected here is only active for measurement channel 1.*	**2.6.5.23** **ANLR panel** Filter
SENSe[1]:**FREQuency:LIMit:LOWer**	**<nu>** Value range: ANLG 22 kHz: 10.0 Hz to 21.9 kHz ANLG 110 kHz: 20.0 Hz to 120 kHz		Lower band limit for tracking the highpass filter frequency for command SENS:FREQ:MODE GENT. If the product of generator frequency and factor drops below the value specified here, the passband frequency of the highpass filter is held at this value.	**2.6.5.23** **ANLR panel** Frq Lim Low
SENSe[1]:**FREQuency:LIMit:UPPer**	**<nu>** Value range: ANLG 22 kHz: FrqLim Low to 21.9 kHz ANLG 110 kHz: FrqLim Low to 120 kHz		Upper band limit for tracking the highpass filter frequency for command SENS:FREQ:MODE GENT. If the product of generator frequency and factor exceeds the value specified here, the passband frequency of the highpass filter is held at this value.	**2.6.5.23** **ANLR panel** Frq Lim Upp
SYSTem:***SPE**aker ...*			In the 22 kHz analyzer, the (residual) Rub & Buzz signal in channel 1 and the unfiltered signal in channel 2 can be monitored. This is done by selecting SYST:SPE:SOUR FNC1 | FNC2 provided the selected channel is also active as a measurement channel.	**2.6.5.23** **ANLR panel** SPEAKER

3.10.2.5.17 Input Level of Digital Signal (DIG INP AMP)

Command	Parameter	Basic unit	Meaning	Section
SENSe2:FUNCtion	'**DIG**Inpampl'		→ Measurement of digital input amplitude, see 3.10.2.4.20 Available only in Meas Mode COMMON/INP ("SENS:DIG:FEED CINP")	2.6.5.16 **ANLR-Panel** INPUT DISP → DIG INP AMPL
SENSe2:UNIT[]	**V | DBV | DBU | DBM W | DPCTV | DV | VVR PCTVVR | DPCTW DW | PPR | PCTPPR DBR**		Unit for result display of digital input amplitude.	**2.6.5.16** **ANLR-Panel** Unit
SENSe2[:VOLTage|POWer]**:REF**erence:***MODE***	***VAL**ue* ***STOR**e* ***DIG**outampl*		Reference value for result display in relative units provided a referenced unit is selected. → Reference value specified with the following command. → The current measurement result is stored as reference value. → The currently valid and each newly set generator voltage is stored as reference value.	**2.6.5.16** **ANLR-Panel** Reference → VALIE: → STORE → DIG OUT AMP
SENSe2[:VOLTage|POWer]**:REF**erence	**<nu>** 100 pV to1000 V	V	Numerical entry of reference value.	**2.6.5.16** **ANLR-Panel**

3.10.2.5.18 Phase Measurement (PHAS TO REF)

Command	Parameter	Basic unit	Meaning	Section
SENSe2:**FUNC**tion '**PHAS**etoref'			→ Measurement of phase between digital input and reference input see 3.10.2.4.20 Nur verfügbar im Meas Mode JITTER/PHAS (SENS:DIG:FEED JPH"	**2.6.5.17** **ANLR-Panel** INPUT DISP → PHAS TO REF
SENSe2:**UNIT**[]	**UI | PCTFRM | DEGFRM** **NS**		Unit for result display of phase.	**2.6.5.17** **ANLR-Panel** Unit

3.10.2.5.19 PROTOCOL

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FUNC**tion	**"PROTocol"**		Protocol data of the digital AES/EBU interface are displayed in the graphics window.	**2.6.5** **ANLR panel** Function → PROTOCOL

3.10.2.5.20 INPUT DISP

Command	Parameter	Basic unit	Meaning	Section
SENSe2:**FUNC**tion	**"OFF"** **"PEAK**voltage"		→ Input peak measurement off → Display of input peak value for all analyzers in all measurement modes In the **digital analyzer** the input signal is sampled with the user-determined sample rate (see **2.6.3**). In the **analog analyzer** the input signal is sampled with the following clock rates after input level control: ANLG 22 kHz with 48 kHz, ANLG 110 kHz with 307.2 kHz The input peak measurement mainly serves for level control and shows peak values of the AC-coupled input signal in front of the filters.	2.6.5.18 **ANLR panel** INPUT DISP → OFF → PEAK → RMS → PHAS to REF → DIG INP AMP
	"RMS"		→ Input RMS measurement for the analog analyzers INST2 A22 I A100, and the digital analyzers INST D48 in the measurement mode SENS:DIG:FEED ADAT for measurement functions SENS:FUNC 'THD'I'THDNsndr'I'MDIST'I'DFD'I'FFT' The input RMS measurement can be displayed in the form of a sweep curve if DISP:TRAC:FEED 'SENS2:DATA' is set in the DISPLAY panel	
	"PHASetoref"		→ Display of frame phase of the signal with jitter between AUDIO and REF input. This measurement can be carried out **simultaneously** with any measurement function available for the JITTER signal: SENS:FUNC 'RMS'I'RMSS'I'PEAK'I'FFT'I'WAV'I'PROT'	
	"DIGInpampl"		→ Display of digital input amplitude at the selected digital input (XLR or BNC). Only with jitter option (UPL-B22) in the measurement mode COMMON/INP. (INST2 D48 mit SENS:DIG:FEED JPH) This measurement can be carried out **simultaneously** with any measurement function available for the COMMON signal: SENS:FUNC 'RMS'I'RMSS'I'PEAK'I'FFT'I'WAV'	
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	see 3.10.4 Units for IEC Measurement Results		Display units for RMS measurement	2.4 Unit Ch1/CH2

Command	Parameter	Basic unit	Meaning	Section
SENSe2[:VOLTage|POWer]:**REF**erence:**MODE**	*CH1Store* *CH2Store* *STORe* *CH1Meas* *CH2Meas* *GENTrack* *DIGoutampl* *VALue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the results in reference-related units. → The value measured of channel 2 is used as a reference for the results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The currently set generator output level is used as a reference. → The measured value is referenced to the level of the digital signal set in the digital generator (see 2.6.5.18 INPUT) that is to - "Unbal Vpp", with the UNBAL input selected, and to - "Bal Vpp", with the BAL input selected. Permissible only in the Meas Mode COMMON/INP (SENS:DIG:FEED CINP) with display of digital input amplitude INPUT DISP = DIG INP AMP (SENS2:FUNC 'DIGI') if GENERATOR INSTRUMENT = DIGITAL is set. → The reference value is entered using the next command.	2.6.5.1 **ANLR panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → DIG OUT AMP → VALUE:
SENSe2[:VOLTage|POWer]:**REF**erence	**<nu>** Analog instrument 1µV to 1000V Digital instrument 0.0 to 1.0 FS	V FS	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Reference

3.10.2.5.21 Frequency Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe3:**FUNC**tion	"OFF" "**FREQ**uency" "**SFREq**uency"		→ Frequency measurement off → Frequency measurement on → Sample frequency measurement on for digital instrument.	2.6.5.19 **ANLR panel** FREQ/PHAS → OFF → FREQ → SAMPLE FREQ
SENSe[1]:**FREQ**uency:**APER**ture:**MODE**	**FAST** **PREC**ision		Definition of measurement time and precision of the frequency measurement for the measurement functions OFF and RMS. Does not influence the other measurement functions. → The frequency measurementis set to attain optimum speed → The frequency measurement is set to attain optimum precision	**2.6.5.19** **ANLR-Panel** Meas Time → FAST → PRECISION
SENSe3:**FREQ**uency:**UNIT**[1|2]	**HZ|DHZ|DPCTHZ|** **TOCT|OCT|DEC|** **F|FR**		Display units for results of frequency measurement.	2.4 **ANLR panel** Unit Ch1/Ch2
SENSe3:**FREQ**uency:**REF**erence:**MODE**	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***STOR**e* ***GENT**rack* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the output of results in reference-related units. → The value measured of channel 2 is used as a reference for the output of results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The currently set generator output level is used as a reference. → The reference value is entered using the next command.	2.6.5.1 **ANLR panel** Ref Freq → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:
SENSe3:**FREQ**uency:**REF**erence	**<nu>** - 1 MHz to 1 MHz	Hz	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Ref Freq
SENSe3:**FREQ**uency:**SETT**ling:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions Frequency settling not selectable for SENSe:DIGital:FEED PHASe|CINPut	2.3.4.2 **ANLR panel** Freq Settl

3.10.2.5.22 Combined Frequency, Phase and Group-Delay Measurement

Combined Frequency and Phase Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe3:FUNCtion	"**OFF**" "**FQPH**ase"		→ Combined frequency and phase measurement off. → Combined frequency and phase measurement on.	2.6.5.19 **ANLR panel** FREQ/PHASE → OFF → FREQ&PHASE
SENSe3:FREQuency:**UNIT**[1]	**HZ|DHZ|DPCTHZ|TOCT|OCT|DEC|FFR**		Display units for results of frequency measurement.	2.4 **ANLR panel** Unit Ch1
SENSe3:PHASe:UNIT2	**DEG|RAD|DDEG|DRAD|**		Display units for results of phase measurement.	2.4 **ANLR panel** Unit Ch2
SENSe3:FREQuency:**REF**erence:**MODE**	***STORe*** ***GENTrack*** ***VALue***		→ The current frequency measurement result is stored as reference value. → The currently set generator frequency is used as a reference. → The reference value is entered using the next command.	2.6.5.1 **ANLR panel** Ref Freq → STORE → VALUE: → GEN TRACK
SENSe3:FREQuency:**REF**erence	**<nu>** - 1 MHz to 1 MHz	Hz	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Reference

Command	Parameter	Basic unit	Meaning	Section
SENSe3:*PHASe*:*FORM*at	*POS*itive *POSN*egative *NEG*ative *RAD* *RADB*ipolar *RADN*egative		Display format for phase measurement → 0 to 360° → - 180° to -180° → - 360° to 0 ° → 0 to 2 π → - π to + π → -2 π to 0	2.6.5.19 **ANLR panel** Format Pha → 0 .. 360° → -180° .. 180° → - 360° .. 0° → 0 .. 2 π → - π .. + π → -2 π .. 0
SENSe3:*PHASe*:REFerence:MODE	*STORe* *VAL*ue		→ The current phase measurement result is stored as reference value. → The reference value is entered using the next command.	2.6.5.1 **ANLR panel** Reference → STORE → VALUE:
SENSe3:*PHASe*:REFerence	<nu> -360° to +360°	DEG	Numerical entry of reference value .	2.6.5.1 **ANLR panel** Reference
SENSe3:FREQuency:SETTling:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Freq Settl
SENSe3:*PHASe*:SETTling:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Phas Settl

Combined Frequency and Group-Delay Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe3:FUNCtion	"OFF" "FQGRoupdelay"		→ Combined frequency and group-delay measurement off → Combined frequency and group-delay measurement on. With RSM measurements, POST-FFT is automatically switched on as the frequency information is obtained from FFT.	2.6.5.19 **ANLR panel** FREQ/PHASE → FREQ&GRPDEL
SENSe3:FREQuency:UNIT[1]	**HZ|DHZ|DPCTHZ|** **TOCT|OCT|DEC|** **FFR**		Display units for results of frequency measurement	2.4 **ANLR panel** Unit Ch1
SENSe3:PHASe:UNIT2	**S** **DS** **DEG** **RAD**		Display units for results of group-delay measurement ***Note:*** *In addition to group delay (in s), phases outside the range ±360° can be measured in DEG or RAD when the frequency sweep mode has been selected.*	2.4 **ANLR panel** Unit Ch2
SENSe3:FREQuency:REFerence:MODE	***STORe*** ***VALue*** ***GENTrack***		→ The current frequency measurement result is stored as reference value. → The reference value is entered using the next command. → The currently set generator frequency is used as a reference value.	2.6.5.1 **ANLR panel** Ref Freq → STORE → VALUE: → GEN TRACK
SENSe3:FREQuency:REFerence	**<nu>** -1 MHz to 1 MHz	Hz	Numerical entry of reference value.	2.6.5.1 **ANLR panel** Ref Freq
SENSe3:*PHASe*:REFerence:MODE	***STORe*** ***VALue***		→ The current phase measurement result is stored as reference value. → The reference value is entered using the next command.	2.6.5.1 **ANLR panel** Ref Phase → STORe → VALUE:
SENSe3:*PHASe*:REFerence	**<nu>** -360 s to +360 s	s	Numerical entry of reference value	2.6.5.1 **ANLR panel** Ref Phase
SENSe3:FREQuency:SETTling:.....			For settling commands see 3.10.2.4.1 Common Parameters for Analyzer Functions	2.3.4.2 **ANLR panel** Freq Settl

3.10.2.5.23 Sample Rate Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe3:**FUNC**tion	'OFF' 'SFREquency'		→ Off → The measured sampling frequency is displayed on the channels switched on Available only for instrument D48	2.6.5.21 **ANLR-Panel** FREQUENCY → SAMPLE FREQ
SENSe[1]:**FREQ**uency:**APER**ture:**MODE**	**FAST** **PREC**ision		Definition of measurement time and precision of the frequency measurement for the measurement functions OFF and RMS. Does not influence the other measurement functions. → The frequency measurementis set to attain optimum speed → The frequency measurement is set to attain optimum precision	**2.6.5.19** **ANLR-Panel** Meas Time → FAST → PRECISION
SENSe3:**FREQ**uency:**UNIT**[1]	**HZ | DHZ | DPCTHZ | TOCT | OCT | DEC | FFR**		Selection of the result units for channel 1	2.4 **ANLR-Panel** Unit Ch1
SENSe3:**FREQ**uency:**UNIT2**	**HZ | DHZ | DPCTHZ | TOCT | OCT | DEC | FFR**		Selection of the result units for channel 2.	2.4 **ANLR-Panel** Unit Ch2
SENSe3:**FREQ**uency:**RE**Ference:***MODE*	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**ea* ***STOR**e* ***GENT**rack* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured of channel 1 is used as a reference for the output of results in reference-related units. → The value measured of channel 2 is used as a reference for the output of results in reference-related units. → For a single-channel measurement, the current measurement result is stored as a reference. → The currently set generator output level is used as a reference. → The reference value is entered using the next command.	2.6.5.19 **ANLR-Panel** Ref Freq → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:

Command	Parameter	Basic unit	Meaning	Section
SENSe3:**FREQ**uency:**REF**erence	<nu> -1 MHz ... 1 MHz	Hz	Numerical entry of reference value.	2.6.5.1 **ANLR-Panel** Ref Freq
SENSe3:**FREQ**uency:**SETT**ling:...			For settling commands see **3.10.2.4.1 Common Parameters for** Analyzer Functions	2.3.4.2 **ANLR-Panel** Freq Settl

3.10.2.5.24 Terzanalyse

Command	Parameter	Basic unit	Meaning	Section
SENSe:**FUNC**ion	'*THIRdoct*'		The analysis is performed according to standard IEC 1260 of 1995 with level accuracy of class 0 (± 1,0 dB). This selection is only available in combination with Option UPL-B6 (Extended Analysis Functions). It is generally not available with the 110 kHz analyzer. For a detailed example see 3.15.19 Readout of Blockdata of Third Octave Measurement	**2.6.5.24** **ANLR-Panel** Function → 1/3 OCTAVE
SENSe[1]:**VOLT**age:**APER**ture:**MODE**	**VAL**ue		Measurement Time of third analysis → The only parameter determining the measurement speed is the measurement time, which is entered with the next command. The measurement time also determines the update rate of the third analysis.	**2.6.5.24** **ANLR-Panel** Meas Time → VALUE:
SENSe[1]:**VOLT**age:**APER**ture	<nu> 64 ms ... 43200s	s	Numerical entry of measurement time of the third analysis.	**2.6.5.24** **ANLR-Panel** Meas Time
SENSe:**VOLT**age:*INTV*:**MODE**	**OFF** ***FOR**ever* ***SMO**oth* ***EDGE***		Hold function for the maximum result of each third. Reset by "INIT:CONT ON" → Max-hold function switched off; only the third bars are displayed. → Max-hold function switched on; the markers lie on the maximum values; reset only by starting the measurement with "INIT:CONT ON". → Max-hold function switched on; the markers lie on the maximum values for the "hold time" to be set with the following command (SENSe[1]:VOLTage:INTVtime <n>) and then decay exponentially (time constant 0.5 s). → Max-hold function switched on; the markers remain on the maximum values for the "hold time" to be set with the following command (SENSe[1]:VOLTage:INTVtime <n>) and then go back to the current measurement value for the third.	**2.6.5.24** **ANLR-Panel** Max Hold → OFF → FOREVER → SLOW DECAY → FAST DECAY

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**VOLT**age:***INTV**time*	**<nu>** 20 ms ... 100 s	s	Setting of the time for which the maximum value of a third is held before the marker returns to the measured value. The selected hold time does not influence the decay time. Only for Max Hold = SLOW DECAY (SENSe:VOLTage:INTV:MODE SMOoth) und Max Hold = FAST DECAY (SENSe:VOLTage:INTV:MODE EDGE)	**2.6.5.24** **ANLR-Panel** Holdtime
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]	**V** | **DBV** | ***DBU*** / ***FS*** / **DBM** | **W** | ***DPCTV*** / ***DV*** / ***VVR*** / ***PCTVVR*** / ***DPCTW*** /***DW*** / ***PPR*** / ***PCTPPR*** / ***PCTFS*** / ***DBFS*** / ***DPCT*** /***DBR***		Units for the third analysis measurement results	**2.4** **ANLR-Panel** Unit Ch1/Ch2
SENSe[1][:VOLTage|POWer]:**REF**erence:**MODE**	***CH1S**tore* ***CH2S**tore* ***CH1M**eas* ***CH2M**eas* ***VAL**ue*		→ For a two-channel measurement, the current measurement result of channel 1 is stored as a reference. → For a two-channel measurement, the current measurement result of channel 2 is stored as a reference. → The value measured in channel 1 is used as a reference for the output of results in reference-related units. → The value measured in channel 2 is used as a reference for the output of results in reference-related units. → The reference value is entered using the next command.	**2.6.5.1** **ANLR-Panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → VALUE:
SENSe[1]:**FILT**er[1] ...			See 3.10.3 Selecting the Analyzer Filters	**2.7.1** **ANLR-Panel** Filter
SENSe[1]:**FREQ**uency:**LIM**it:**LOW**er	**<nu>** ANLG 22 kHz: 10.0 Hz to 21.938 kHz DIG 48 kHz: 10.0 Hz to f_{max}	Hz	Lower band limit for third analysis.	**2.6.5.24** **ANLR-Panel** → Frq Lim Low

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FREQ**uency:**LIMi**t:**UPP**er	**<nu>** ANLG 22 kHz: FrqLim Low to 21.938 kHz ANLG 110 kHz: FrqLim Low to f_{max}	Hz	Upper band limit for third analysis.	**2.6.5.24** **ANLR-Panel** → Frq Lim Upp

3.10.3 Selection of Analyzer Filter

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er<i>	<i>*) = 1 to 3 **OFF** Query returns name of the filter switched on: **UFIL1** : **UFIL9** **AWE** **CMES** **CCIT** **CCIR** **CCIU** **DEMP5015** **DEMP50** **DEMP75** **DEMP17** **WRUM** **URUM** **DCN** **CARM** **IECT** **JITT**		Switches off the filter in the analyzer measurement functions RMS, PEAK, QPE or THDN.	2.7.1 **FILTER panel** Filter
SENSe[1]:**FILT**er<i>	<i>*) 1 to 3 **OFF**		Switches off the filter in the analyzer measurement functions RMS, PEAK, QPE or THDN.	2.7.1 **FILTER panel** Filter
SENSe[1]:**FILT**er<i>:*UFILter1... UFILter9*[:STATe]	<i>*) 1 to 3 **ON|OFF**		A HPASs, LPASs, BPASs, BSTOp, NOTCh, TERZ, OCTav or FILE filter with freely selectable parameters (see SENSe:FILTer<n>:HPASs|:LPASs ... and subsequent commands) can be assigned to each of the 9 user filters (UFILter). When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er<i>:**CCITt**[:STATe]	<i>*) 1 to 3 **ON|OFF**		For psophometric measurements When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → CCITT
SENSe[1]:**FILT**er<i>:***CCIU**nweight*[:STATe]	<i>*) 1 to 3 **ON|OFF**		Bandpass filter 20 Hz to 20 kHz When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → CCIR unwtd
SENSe[1]:**FILT**er<i>:**CCIR**weight[:STATe]	<i>*) 1 to 3 **ON|OFF**		For RFI voltage measurements When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → CCIR wtd
SENSe[1]:**FILT**er<i>:**AWE**ighting[:STATe]	<i>*) 1 to 3 **ON|OFF**		For RFI voltage measurements When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → A Weighting
SENSe[1]:**FILT**er<i>:**CMES**sage[:STATe]	<i>*) 1 to 3 **ON|OFF**		For transmission measurements When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → C MESSAGE
SENSe[1]:**FILT**er<i>:***DEMP**hasis**50*[:STATe]	<i>*) 1 to 3 **ON|OFF**		For unweighted and weighted noise measurements When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → DEEMPH 50
SENSe[1]:**FILT**er<i>:***DEMP**hasis**75*[:STATe]	<i>*) 1 to 3 **ON|OFF**		For unweighted and weighted noise measurements When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → DEEMPH 75

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er<i>:***DEMP**hasis17*[:STATe]	<i>*) 1 to 3 **ON|OFF**		For unweighted and weighted noise measurements When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → DEEMPH J.17
SENSe[1]:**FILT**er<i>:***DEMP**hasis5015*[:STATe]	<i>*) 1 to 3 **ON|OFF**		For unweighted and weighted noise measurements When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → DEEM 50/15
SENSe[1]:**FILT**er<i>:***WRUM**ble*[:STATe]	<i>*) 1 to 3 **ON|OFF**		Weighted noise measurement for testing tape recorders When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → RUMBLE wtd
SENSe[1]:**FILT**er<i>:***URUM**ble*[:STATe]	<i>*) 1 to 3 **ON|OFF**		Unweighted noise measurement for testing tape recorders When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → RUMBLE unw
SENSe[1]:**FILT**er<i>:***DCN**oise*[:STATe]	<i>*) 1 to 3 **ON|OFF**		Highpass filter for measuring the DC noise When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → DC NOISE HP
SENSe[1]:**FILT**er<i>:***CARM***[:STATe]	<i>*) 1 to 3 **ON|OFF**		Filter for weighted noise measurements in line with older regulations. When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.1 **FILTER panel** Filter → CCIR ARM
SENSe[1]:**FILT**er<i>:**JITT**er[:STATe]	<i>*) = 1 to 4 **ON I OFF**		Weighting of jitter transmission function	2.7.1 **FILTER panel** Filter → JITTER wtd

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:**FILT**er<i>:***IECTuner***[:STATe]	<i>*) 1 to 4 **ON|OFF**		Filter for tuner measurements to DIN/IEC 315	2.7.1 **FILTER panel** Filter → IEC Tuner
SENSe[1]:***UFILter***<i>:**HPAS**s[:STATe]	<i> 1 to 9 **ON**		Highpass When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.2 **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFILter***<i>:**LPAS**s[:STATe]	<i> 1 to 9 **ON**		Lowpass When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.2 **FILTER panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:***BPASs***[:STATe]	<i> 1 to 9 **ON**		Bandpass When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.2 **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFILter***<i>:***BSTOp***[:STATe]	<i> = 1 to 9 **ON**		Bandpass When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.2 **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFILter***<i>:***NOTCh***[:STATe]	<i> 1 to 9 **ON**		Notch filter When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.2 **FILTER panel** FILTER 01 to 09

*) <i> stands for the filter of analyzer measurement functions RMS, PEAK, QPE and THDN, which has been assigned the specified filter function.
Example:
" SENS: FUNC ' RMS ' "
" SENS: FILT1:DEMP5015 ON"
" SENS: FILT3:CCIT ON"
causes the following setting in the ANALYZER panel in the RMS & S/N measurement function
:

• Notch (Gain)	OFF	
• Filter	DEEM 50/15	i = 1
• Filter	OFF	i = 2
• Filter	CCITT	i = 3
• Func Settl	OFF	

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:***UFIL**ter*<i>:***TOCT**ave*[:STATe]	<i> 1 to 9 **ON**		Third-octave filter (Third Octave) When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.2 **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFIL**ter*<i>:***OCTav**[:STATe]	<i> 1 to 9 **ON**		Octave filter When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.2 **FILTER panel** FILTER 01 to 09
SENSe[1]:***UFIL**ter*<i>:***FILE**[:STATe]	<i> 1 to 9 **ON**		User-defined filter When a filter is switched ON the previously active filter is automatically switched OFF.	2.7.2 **FILTER panel** FILTER 01 to 09
SENSe:**UFIL**ter[1...9]:**DEGR**ee	**N4** **N8**		Selection of order for highpass and lowpass filters → Order 4 → Order 8	**2.7.2** **FILTER panel** Degree → 4 → 8
SENSe[1]:***UFIL**ter*<i>:***PASS**b*	<i> = 1 to 9 <**nu**> = LL*) For MB limit see 2.6.1 Selecting the Analyzer	Hz	Passband of HPASs and LPASs	2.7.2.2 **FILTER panel** FILTER 01 to 09 → Passband
SENSe[1]:***UFIL**ter*<i>:***STOP**b***?**	<i> 1 to 9 Query only		Queries the stopband of HPASs and LPASs	2.7.2.2 **FILTER panel** FILTER 01 to 09 → Stopband
SENSe[1]:***UFIL**ter*<i>:***PASS**b:**LOW**er*	<i> = 1 to 9 <**nu**> = LL*) For MB limit see 2.6.5.1 Common Parameters of Analyzer Functions	Hz	Lower passband of BPASs and BSTOp	2.7.2.3 **FILTER panel** FILTER 01 to 09 → Passb low

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:***UFIL**ter*<i>:***PASS**b:**UPP**er*	<i> = 1 to 9 <**nu**> = LL*) For MB limit see 2.6.1 Selecting the Analyzer	Hz	Upper passband of BPASs and BSTOp	2.7.2.3 **FILTER panel** FILTER 01 to 09 → Passb upp
SENSe[1]:***UFIL**ter*<i>:***STOP**b:**LOW**er?*	<i> 1 to 9 Query only		Queries the lower stopband of BPASs and BSTOp	2.7.2.3 **FILTER panel** FILTER 01 to 09 → Stopb low
SENSe[1]:***UFIL**ter*<i>:***STOP**b:**UPP**er?*	<i> 1 to 9 Query only		Queries the upper stopband of BPASs and BSTOp	2.7.2.3 **FILTER panel** FILTER 01 to 09 → Stopb upp
SENSe[1]:***UFIL**ter*<i>:***CENT**er*	<i> = 1 to 9 <**nu**> = LL*) For MB limit see 2.6.1 Selecting the Analyzer	Hz	Center frequency of NOTCh, TOCT OCTAv	2.7.2.4 2.7.2.5 **FILTER panel** FILTER 01 to 09 → Center Frq
SENSe[1]:***UFIL**ter*<i>:***WIDT**h*	<i> = 1 to 9 <**nu**> = LL*) For MB limit see 2.6.1 Selecting the Analyzer	Hz	Center frequency of NOTCh, TOCT OCTAv	2.7.2.4 and 2.7.2.5 **FILTER panel** FILTER 01 to 09 → Width
SENSe[1]:***UFIL**ter*<i>:***ATT**enuation*	<i> 1 to 9 <**nu**> 3 to 120 dB	dB	Attenuation of all filters except FILE Def. The value may be corrected in the UPL and queried.	2.7.2.1 **FILTER panel** FILTER 01 to 09 → Atten
SENSe[1]:***UFIL**ter*<i>:***DEL**ay*	Query only for all filters except for file-defined filters <i> = 1 to 9 <**nu**> = 0 to 1 s	s	Settling time of FILE-defined filters	2.7.2.7 **FILTER panel** FILTER 01 to 09 → Delay

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:*UFILter*<i>:*DELay*?	<i> 1 to 9 Query only		Queries the settling time of filters HPASs, LPASs, BPASs, BSTOp, NOTCh, TOCT OCTav	2.7.2.1 **FILTER panel** FILTER 01 to 09 → Delay
SENSe[1]:*UFILter*<i>:*FILE*	**"filename"** <i> 1 to 9		Path and file name of file-defined filter data e.g. "C:\UPL\USER\MYFILT.ZPZ"	2.7.2.7 **FILTER panel** FILTER 01 to 09 → Filename

*) LL = Lower limit value for instruments 22: 24 Hz
A110: 171 Hz
D48: Sample Freq*Oversamp/2000 (see 2.6.3 Configuration of the Digital Analyzer)

3.10.4 Units for IEC/IEEE Measurement Results

Command	Parameter		Meaning	Section
SENSe[1|2][:VOLTage|POWer]:**UNIT**[1|2]	V		V	2.4 **ANLR panel** Unit Ch1/Ch2
	MV (only for SENS[1]...)		mV	
	UV (only for SENS[1]...)		µV	
	DBV		dBV } Absolute units for analog level measurement results	
	DBU		dBu	
	W		W	
	DBM		dBm	
	DV		ΔV	
	DPCTV		Δ%V	
	VVR		V/VR	
	PCTVVR		$\%V/V_r$ } Relative units for analog level measurement results	
	DW		ΔW	
	DPCTW		Δ%W	
	PPR		P/P_r	
	PCTPPR		$\%P/P_r$	
	DBR		dBr	
	DB (only for SENS[1]...)		dB } Relative units for intermodulation measurements and W&F	
	PCT (only for SENS[1]...)		%	
	FS		FS	
	LSBS		LSBs } Absolute units for digital phase measurements	
	DBFS		dBFS	
	BITS		bits	
	DPCT		Δ%	
	PCTFS		%FS } Relative units for digital level measurements	
	UI		UI } Absolute units for digital jitter and phase measurements	
	NS		ns	

Command	Parameter		Meaning	Section
SENSe[1|2][:VOLTage|POWer]:**UNIT**[1|2]	***PPMUI*** ***DBUI***		ppm, DBUI } Absolute units for digital jitter measurements	2.4 **ANLR panel** Unit Ch1/Ch2
	UIR ***PCTUI***		Uir, %UI } Relative units for digital jitter measurements	
	PCTFRM (only for SENS2..) ***DEGFRM*** (only for SENS2..)		%FRM, FRM } Absolute units for digital phase measurement results	
SENSe3:**FREQ**uency:**UNIT**[1|2]	**HZ** ***DHZ*** ***DPCTHZ*** ***TERZ*** ***OCT*** ***DEC*** ***FFR***		Absolute and relative units for frequency readout Hz ΔHz Δ%Hz Terz Oct Dec f/fr	2.4 **ANLR panel** Unit Ch1/Ch2
SENSe3:**PHAS**e:**UNIT**	**DEG** **RAD** ***DDEG*** ***DRAD*** ***S*** ***DS***		Absolute and relative units for phase readout ° In addition to group delay (in s), phases outside the range ±360° RAD can be measured in DEG or RAD Δ° ΔRAD s (for group delay) Δs (for group delay)	2.4 **ANLR panel** Unit Ch1/Ch2

Display units selectable for measurement results:

Example:
Display units selectable for measurement results
SENSe[1][:VOLTage|POWer]:**UNIT**[1|2]:

Instrument	Measurement function	Selectable display units
"INST2 A22 | A110" "INST2 A22 | A110" "INST2 A22" "INST2 A22" "INST2 A22 | A110" "INST2 A22 | A110"	"SENS:FUNC 'RMS' | 'RMSS' | 'PEAK' | 'QPE' | 'DC' | 'FFT' "	"SENS:UNIT[1|2] V | DBV | DBU | DBM | W | DPCTV | DV | VVR | PCTVVR | DPCTW | DW | PPR | PCTPPR | DBR"
"INST2 A22 | A110"	"SENS:FUNC 'THDN'" und "SENS:FUNC:MMOD LNOI | NOIS "	
"INST2 A22 | A110"	"SENS:FUNC 'WAV" and "SENS:FUNC:MMOD COMP"	
"INST2 A22 | A110"	"SENS:FUNC 'THD' | 'MDIS' | 'DFD' "	"SENS:UNIT[1|2] DB | PCT"
"INST2 A22 | A110"	"SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD THDN | NOIS"	
"INST2 A22"	"SENS:FUNC 'WAF'"	"SENS:UNIT[1|2] PCT"
"INST2 A22 | A110"	"SENS:FUNC 'WAV" and "SENS:FUNC:MMOD STAN"	"SENS:UNIT[1|2] V | MV | UV | DPCTV | DV | VVR | PCTVVR"
"INST2 A22 | A110"	"SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD SNDR"	"SENS:UNIT[1|2] DB"

Instrument	Measurement function	Selectable display units
"INST2 D48" and "SENS:DIG:FEED ADAT"	"SENS:FUNC 'RMSS' | 'PEAK' | 'QPE' " "SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD LNOI | NOIS " "SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD COMP"	"SENS:UNIT[1|2] FS | PCTFS | DBFS | DPCT | DBR | LSBS | BITS"
	"SENS:FUNC 'THD' | 'MDIS' | 'DFD' " "SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD THDN | NOIS	"SENS:UNIT[1|2] DB | PCT"
	"SENS:FUNC 'WAF'"	"SENS:UNIT[1|2] PCT"
	"SENS:FUNC 'DC'" "SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD STAN"	"SENS:UNIT[1|2] FS | PCTFS | DPCT | LSBS"
	"SENS:FUNC 'THDN'" and "SENS:FUNC:MMOD SNDR"	"SENS:UNIT[1|2] DB"

Instrument	Measurement function	Selectable display units
"INST2 D48" and "SENS:DIG:FEED JPH"	"SENS:FUNC 'RMS' | 'RMSS' | 'PEAK' | FFT" "SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD COMP"	"SENS:UNIT[1|2] UI | PCTUI | PPMUI | NS | UIR | DBR | DBUI"
	"SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD STAN"	"SENS:UNIT[1|2] UI | PCTUI | PPMUI | NS | UIR"
"INST2 D48" and "SENS:DIG:FEED CINP"	"SENS:FUNC 'RMS' | 'RMSS' | 'PEAK' | FFT" "SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD COMP"	"SENS:UNIT[1|2] V | DBV | DBU | DBM | W | DPCTV | DV | VVR | PCTVVR | DPCTW | DW | PPR | PCTPPR | DBR"
	"SENS:FUNC 'WAV'" and "SENS:FUNC:MMOD STAN"	"SENS:UNIT[1|2] V | MV | UV | DPCTV | DV | VVR | PCTVVR"

Display units selectable for input, peak, RMS and phase measurements
SENSe2[:VOLTage|POWer]:**UNIT**[1|2]:

Instrument	Measurement function	Selectable display units
"INST2 A22 | A110"	"SENS2:FUNC 'PEAK' | 'RMS'"	"SENS2:UNIT[1|2] V | DBV | DBU | DBM | W | DPCTV | DV | VVR | PCTVVR | DPCTW | DW | PPR | PCTPPR | DBR"
"INST2 D48" and "SENS:DIG:FEED ADAT"	"SENS2:FUNC 'PEAK'"	"SENS2:UNIT[1|2] FS | PCTFS | DBFS | DPCT | DBR | LSBS | BITS"
"INST2 D48" and "SENS:DIG:FEED JPH"	"SENS2:FUNC 'PEAK'"	"SENS2:UNIT[1|2] UI | PCTUI | PPMUI | NS | UIR | DBR | DBUI"
"INST2 D48" and "SENS:DIG:FEED JPH"	"SENS2:FUNC 'PHAS'"	"SENS2:UNIT UI | PCTFRM | DEGFRM | NS"
"INST2 D48" and "SENS:DIG:FEED CINP"	"SENS2:FUNC 'PEAK | 'DIGI'"	"SENS2:UNIT[1|2] V | DBV | DBU | DBM | W | DPCTV | DV | VVR | PCTVVR | DPCTW | DW | PPR | PCTPPR | DBR"

Display units selectable for frequency, phase and group delay measurements
SENSe3:**FREQ**uency:**UNIT**[1|2] and **SENS**e3:**PHAS**e:**UNIT2**:

Instrument	Measurement function	Selectable display units
"INST2 A22 | A110 | D48"	"SENS3:FUNC 'FREQ'"	"SENS3:FREQ:UNIT[1|2] HZ | DHZ | DPCTHZ | TOCT | OCT | DEC | FFR"
"INST2 A22"	"SENS3:FUNC 'FQPH'"	"SENS3:FREQ:UNIT HZ | DHZ | DPCTHZ | TOCT | OCT | DEC | FFR" "SENS3:PHAS:UNIT DEG | RAD | DDEG | DRAD"
"INST2 A22"	"SENS3:FUNC 'FQGR'"	"SENS3:FREQ:UNIT HZ | DHZ | DPCTHZ | TOCT | OCT | DEC | FFR" "SENS3:PHAS:UNIT S | DS"

3.10.5 Loading and Storing

3.10.5.1 Loading and Storing Instrument Setups

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**INFO**text:**STATe**	**ON** **OFF**		→ During scrolling in the file selection window of the file box the "Info text" for a setup is displayed in the user info line (of minor importance for IEC/IEEE-bus control). → "Info text" is not displayed.	2.9.1.1 **FILE panel** Info Displ → ON → OFF
MMEMory:**LOAD:STATe**	0|2, **"filename"** Query: MMEM:LOAD:STAT? 0 MMEM:LOAD:STAT? 2		0: Load current setup with filename extension .SAC 2: Load complete instrument setup with filename extension .SCO. For loading the R&S default setup under C:UPL \ SETUP \ DEFAULT.SET use command *RST. Switch off the parameter link (see 2.15.8 Transfer of Parameters (Parameter Link Function)) to ensure that the default setup described under annex "A UPL Default Setup" remains unchanged even after an instrument or function change.	2.9.1.1 **FILE panel** Mode / Filename
MMEMory:**STORe:INFO**text	**'string'**		A comment of max. 39 characters can be entered for a description of the measurement, a DUT, etc. This comment is displayed in the file box when a setup is loaded by scrolling through the file selection window and SYST:INFO:STAT ON has been selected.	**2.9.1.1** FILE panel Info Text
MMEMory:**STORe:STATe**	0|2,**"filename"** Query: MMEM:STOR:STAT? 0 MMEM:STOR.STAT? 2		0: Store current setup under filename extension .SAC 2: Store complete instrument setup under filename extension .SCO.	2.9.1.1 **FILE panel** Mode / Filename
MMEMory:**STORe:STATe**:***RONLy***	**ON** **OFF**		→ File is write-protected → File is not write-protected	2.9.1.1 **FILE panel** Attrib → REAN ONLY → READ/WRITE

3.10.5.1.1 Loading and Storing Traces and Lists

Command	Parameter	Basic unit	Meaning	Section
MMEMory:**STOR**e:***FORM**at*	***BIN*** ***ASCii***		→ Data stored in binary format → Data stored in ASCII format	2.9.1.2 **FILE panel** Format → REAL → ASCII
MMEMory:**STOR**e:**TRAC**e	**TRACe1,"filename"** **TRACe2,"filename"** **TR1A**nd2,**"filename"** Query: MMEM:STOR:TRAC? TRAC[1|2] MMEM:STOR:TRAC? TR1A		→ Store trace A buffer under "filename" → Store trace B buffer under "filename" → Store trace pair under "filename"	2.9.1.2 **FILE panel** Store → TRACE A → TRACE B → TRACE A+B
MMEMory:**STOR**e:***LIST***	***LIST1*****,"filename"** ***LIST2*****,"filename"** **DWELl,"filename"** Query: MMEM:STOR:LIST? LIST[1|2] MMEM:STOR:LIST? DWEL		→ Store X-axis list under "filename" → Store Z-axis list under "filename" → Store dwell-time list under "filename"	2.9.1.2 **FILE panel** Store → X-Axis → Z-Axis → DWEL VALUE

3.10.5.1.2 Storing Limit Violations (Error Reports)

Command	Parameter	Basic unit	Meaning	Section
MMEMory:STORe:*FORMat*	***BIN*** ***ASCii***		→ Data stored in binary format → Data stored in ASCII format	2.9.1.2 **FILE panel** Format → REAL → ASCII
MMEMory:STORe:LIST	***ERRors*,"filename"** ***LIMUpper*,"filename"** ***LIMLower*,"filename"** Query: MMEM:STOR:LIST? ERR MMEM:STOR:LIST? LIMU MMEM:STOR:LIST? LIML		→ Store limit error under "filename" → Store upper tolerance curve under "filename" → Store lower tolerance curve under "filename"	2.9.1.2 **FILE panel** Store → LIM REPORT → LIM UPPER → LIM LOWER

3.10.5.1.3 Storing Equalization Files

Command	Parameter	Basic unit	Meaning	Section
MMEMory:STORe:*FORMat*	*BIN* *ASCii*		→ Data stored in binary format → Data stored in ASCII format	2.9.1.2 **FILE panel** Format → REAL → ASCII
CALCulate:*EQUalize:FEED*	*TRACe1* *TRACe2*		→ Amplitude data read from → Trace buffer A/B	2.9.1.2 **FILE panel** Volt Source → TRACE A → TRACE B
CALCulate:*EQUalize:NORMfreq*	<nu> f_{min} to f_{max}	Hz	Frequency to the level at which is normalized	2.9.1.2 **FILE panel** Norm Freq
CALCulate:*EQUalize:INVert*	**ON** **OFF**		→ Frequency stored in inverted form → Frequency stored without inversion	2.9.1.2 **FILE panel** Invert 1/n → ON → OFF
MMEMory:STORe:*LIST*	*EQUalize*,"**filename**" Query: MMEM:STOR:LIST? EQU		Store equalization file under "filename"	2.9.1.2 **FILE panel** Store → EQUALIZATN

3.10.5.2 Commands for Editing Files and Directories

Command	Parameter	Basic unit	Meaning	Section
MMEMory:**DEL**ete	**"filename"**		Deletes a file.	2.9.2 **FILE panel** Delete
MMEMory:**CDIR**ectory	**"pathname"**		Selects a directory for file operation.	2.9.2 **FILE panel** Work Dir
MMEMory:**COPY**	**"filename1","filenam e2"**		Selects the file to be copied. Specifies the name of the target file (with drive and directory, if required) to which a copy should be made.	2.9.2 **FILE panel** Copy + To

3.10.6 Commands for Graphical Representation of Results

In the following, TRACe1 and TRACe2 serve for differentiating between displayed curves (trace A and trace B), bargraphs and result lists.

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[]:***OPER**ation*	***CURV**eplot* ***LIST**alias **TLIS**t* ***ERR**ors* ***BARG**raph* ***SPEC**trum* ***FFTL**ist* ***FFTE**rrors* ***PROT**ocol*		The parameters below determine the form for the graphics display of measurement results. → Line chart in Cartesian coordinates. → List of numeric values. → List of out-of-tolerance values. In this case the limit check function must be active. → Bargraph display in analog form. → Display of FFT or, in the case of THD, DFD or MOD-DIST, in the form of a schematic spectrum display. → FFT data in tabular form. → FFT limit violation data in tabular form. Limit check function must be active. → Protocol data of the digital AES/EBU interface displayed in the graphics window.	**2.10** **DISP panel** OPERATION → CURVE PLOT 2.10.2 → SWEEP LIST 2.10.4 → SWP LIM REP 2.10.4 → BARGRAPH 2.10.2 → SPECT LIST 2.10.8 → SPC LIM REP 2.10.6 → PROTOCOL
DISPlay[:WINDow]:**TRAC**e[]:**MODE**	***DEL**ete_bef_wr* ***WAT**erfall**CASC**ade* ***MAXH**old*		→ Selects a single trace or a pair of traces. Each new X sweep overwrites the previous trace. → Shifts a single trace (trace pairs not possible) on the Z axis for obtaining a spatial presentation (with FFT-SPECtrum only). → Maximum hold function for FFT SPECtrum for FFT-AVERage = 1.	2.10 **DISP panel** Mode → DEL BEF WR → WATERFAL → MAX HOLD
DISPlay[:WINDow]:**TRAC**e[]:***COUN**t*	<n> recorded: 1 to 100 000 stored: max. 17 traces		Specifies the number of single traces and trace pairs to be recorded together and stored. Automatically sets the number of Z values in the case of a Z sweep.	2.10 **DISP panel** Scan Count

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[1|2]:**FEED**	**"SENSe1:DATA1"** **"SENSe1:DATA2"** **"SENSe2:DATA1"** **"SENSe2:DATA2"** **"SENSe3:DATA1"** **"SENSe3:DATA2"** **"HOLD"** **"FILE"** **"DFILe"** **"OFF"**		Selects the result to be displayed as TRACe1 (or TRACe2). → Measurement function specified by SENSe1:FUNCtion "<>". Value from channel 2 (CH1). → Measurement function specified by SENSe1:FUNCtion "<>2. Value from channel 2 (CH2). → Result of input RMS measurement of channel 1 (CH1) for THD and THDN functions. → Result of input RMS measurement of channel 2 (CH2) for THD and THDN functions. → Measured value from frequency meter, channel 1 (CH1). → Measured value from frequency meter,channel 2 (CH2) if SENS3:FUNC FREQ is selected. Measured value from phase meter, channel 2 (CH2) if SENS3:FUNC FQPH. Measured value from group delay measurement, channel 2 (CH2) if SENS:FUNC FQGR is selected → Retains previously displayed values (no collection of new values). → Displays measured values from a file using the command described below. → Loads a trace pair with scale and reference values or reference trace using the command described below. → Switch-off	2.10.1 **DISP panel** TRACE A/B → FUNC CH1 → FUNC CH2 → INP RMS CH1 → INP RMS CH2 → FREQ CH1 → FREQ CH2 → PHASE → GROUP DEL → HOLD → FILE → DUAL FILE → OFF
MMEMory:**LOAD:TRAC**e	**TRAC**e[1|2],"**filename**" Query: MMEM:LOAD:TRAC? TRAC[1|2]		Loads a trace from a file for display.	2.10.1 **DISP panel** TRACE A/B → FILE + Filename
TRACe:**DATA?**	**TRAC**e[1|2] Query only Query: TRAC? TRAC[1|2]		The trace (block data!) can be read from the UPL to the controller.	2.10.1 **DISP panel**
DISPlay[:WINDow]:**TRAC**e[]:**Y**[:SCALe]:**UNIT**	**<u>** see 3.10.4 Units for IEC Measurement Results	1)	Determines the units for results displayed in numerical form.	2.10.1 **DISP panel** Unit

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[1|**2**]:**Y**[:SCALe]:**RLEV**el:**MODE**	*VALue* *MAXimum* *CURSor[1]* *CURSor 2* *FILE* *HOLD* *OTRAce* *CH1Meas* *CH2Meas* *GENTrack* *IFILe*		A reference value is required for all relative units of TRACe1 or TRACe2. → The subsequently entered value is used as a reference. → Uses the maximum value of the trace once. → The value pointing to the o-cursor is stored as a reference. → The value pointing to the *-cursor is stored as a reference. → Reference for reference-related units is a file indicated by MMEMory:LOAD:TRACe[1|2]REFTrace,"name.TRC". → The reference-trace memory is no longer filled with new (sweep) values. Stored values are retained. → Reference for reference-related units is another trace. → Reference for reference-related units is the value measured in channel 1 or 2 pertaining to the respective reference point (depending on the display measured frequency, function or input result). → The reference trace is erased and reloaded for each measurement using the respective generator setting. → When a trace with the associated reference trace (Internal reference FILe) is loaded, IFILe activates this internal reference file again when another reference has been selected before.	2.10.1 **DISP panel** Reference → VALUE → MAX → oCURSOR → *CURSOR → FILE → HOLD → OTHER TRACE → MEAS CH1 → MEAS CH2 → GEN TRACK → FILE INTERN
DISPlay[:WINDow]:**TRAC**e[]**:Y**[:SCALe]:**RLEV**el	**<nu>**	1)	Entry of reference value for relative units.	2.10.1 **DISP panel** Reference → VALUE
MMEMory:**LOAD:TRAC**e[1|**2**]	**REFT**race,**"filename"** Query: MMEM:LOAD:TRAC[1|2]? REFT		→ File containing the reference-trace data for trace A. Default extension = .TRC	2.10.1 **DISP panel** Reference → FILE + Reference
DISPlay[:WINDow]:**TRAC**e**2:Y**[:SCALe]:***EQUal*	*ON* *OFF*		→ TRACe2 may be displayed on the same axis as TRACe1. In this case no values can be entered for: UNIT,: RLEVel,:SCALe:AUTO,:TOP,:BOTTom and :SPACing for the second axis. → Independent of trace 1.	2.10.1 **DISP panel** Scale B → EQUAL A → NOT EQUAL A

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**[:SCALe]:**AUTO**	**ONCE** **OFF**		→ Uses the minimum and maximum values of the present trace for rescaling the display once. The new scaling data are transferred to and used in DISP:TRAC:Y:TOP <n> and DISP:TRAC:Y:BOTT <n>. → Leaves scaling to the user with the aid of the following two commands.	2.10.1 **DISP panel** Scale → AUTO ONCE → MANUAL ONCE mit Softkey F7 (AUTOSCALE) → F7 (A) → F8 (B)
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**[:SCALe]:**NORM**alize:**MODE**	**CURS**or[1] (o-Cursor) **CURS**or**2** (*-Cursor) **VAL**ue		With normalize the reference curve can be multiplied so that a specific Y value is obtained at the desired Y position. → The multiplier is obtained from the measured value at the cursor position divided by the reference value at this position. Thus the new reference corresponds to the value measured at this position (= 0 dBr). → Entry of a fixed multiplier using the next command: Presettings required: DISP:TRAC[1|2]:OPER CURV and DISP:TRAC[1|2]:FEED 'SENS1:DATA1'|'SENS1:DATA2'|'HOLD' and DISP:TRAC[1|2]:Y:UNIT VVRPCTVVR|PPR|PCTPPR|DBR and DISP:TRAC[1|2]:Y:RLEV:MODE GENT or DISP:TRAC[1|2]:OPER CURV and DISP:TRAC[1|2]:FEED 'SENS3:DATA1'|'SENS3:DATA2'|'HOLD' and DISP:TRAC[1|2]:Y:UNIT TOCT|OCT|DEC|FFR and DISP:TRAC[1|2]:Y:RLEV:MODE GENT	2.10.1 **DISP panel** Normalize → o-Cursor → *-Cursor → VALue
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**[:SCALe]:**NORM**alize	**<nu>** 10^{-12} to 10^{6} or -200 dB to 120 dB	Multi-plier | dB	The specified number is multiplied to obtain the reference value. This allows the reference of a trace to be determined as required.	2.10.1 **DISP panel** Normalize

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRACe**[1|2]:**Y:SPACing**	**LIN**ear **LOG**arithmic		→ Linear spacing of Y axes → Logarithmic	2.10.1 **DISP panel** Spacing → LIN → LOG
DISPlay[:WINDow]:**TRACe**[1|2]:**Y**[:SCALe]:**TOP**	**<nu>**	1)	Sets the upper value of the Y axis (of the dependent value) in the case of DISPlay:TRACe[1|2]:Y:AUTO OFF	2.10.1 **DISP panel** Top
DISPlay[:WINDow]:**TRACe**[1|2]:**Y**[:SCALe]:**BOTTom**	**<nu>**	1)	Sets the lower value of the Y axis (of the dependent value) in the case of DISPlay:TRACe[1|2]:Y:AUTO OFF.	2.10.1 **DISP panel** Bottom
DISPlay[:WINDow]:**TRACe**[1|2]:**X**[:SCALe]:***UNIT***	**<u>** see 3.10.4 Units for IEC Measurement Results		Determines the units for the numeric results displayed on the X axis.	2.10.1 **DISP panel** Unit
DISPlay[:WINDow]:**TRACe**[1|2]:**X**[:SCALe]:**RLEVel**	**<nu>**	2)	Entry of reference value for relative units.	2.10.1 **DISP panel** Reference
DISPlay[:WINDow]:**TRACe**[]:**X**[:SCALe]:**AUTO**	**ON** **OFF**		→ Uses the minimum and maximum values of the present trace for scaling the X axis (once). → Leaves scaling to the user with the aid of the following two commands.	2.10.1 **DISP panel** Scale → AUTO → MANUAL or **Softkey** F7 (AUTOSCALE) → F9 (X)
DISPlay[:WINDow]:**TRACe**[]:**X:SPACing**	**LIN**ear **LOG**arithmic		→ Linear spacing of X axis → Logarithmic	2.10.1 **DISP panel** Spacing → LIN → LOG

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**LEFT**	<nu>	2)	Sets the left-hand value of the X axis (of the independent value) in the case of DISPlay:TRACe:X:AUTO OFF.	2.10.1 **DISP panel** Left
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**RIGHT**	<nu>	2)	Sets the right-hand value of the X axis (of the independent value) in the case of DISPlay:TRACe:X:AUTO OFF. The lower value of LEFT and RIGHT is used as left-hand value.	2.10.1 **DISP panel** Right
DISPlay[:WINDow]:**TEXT**[:DATA]	"string"		Permits a text to be entered that will be displayed within the trace display in the case of DISPlay:TRACe[1|2]:OPERation CURVeplot.	2.10.1 **DISP panel** COMMENT
DISPlay[:WINDow]:**TEXT:LOC**ate	<ny>[,<nx>]		Determines the X and Y position of the text. X and Y are the relative distance from the 0 point of the coordinates in % (0 to 100).	2.10.1 **DISP panel** X Pos, Y Pos
DISPlay[:WINDow]:**TRAC**e[]: **ACT**ive	*CURSor*[1|2]		Switches the cursors alternately on and off. This only affects the display. CURSor1 is marked with o, CURSor2 with *.	2.10.2 **DISP panel** Softkey, 1st level F8
DISPlay[:WINDow]:**TRAC**e[]:*CURSor*[*1*]:**MODE**	*N12* *D12* *OFF*		Parameters used for selecting the cursor function and the type of the displayed numeric cursor values. → Display of measured values A and B and of associated X value. → Display of difference value of A and B at the cursor position and of X value. → The deactivated cursor is no longer displayed.	2.10.2 **Softkey** F8: selects O-CURS. F9: (O-CURSOR) → F6 (A,B) → F7 (A-B) → F11 (ON/OFF)

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[]:***CURS**or2:***MODE	*N12* *D12* *C12* *HL1* *HL2* *HLD1* *HLD2* *OFF*		→ Display of measured values A and B and of associated X value. → Display of difference value of A and B at the cursor position and of X value. → Difference of trace and X values of curves A and B which are marked by the two cursors. → The *-cursor is switched to horizontal line. Its Y value and intersections with TRACe1 (if any) are displayed. → Intersections with TRACe2 are displayed. → The *-cursor is switched to horizontal line. The difference between its Y value and the Y value of the o-cursor are displayed. Intersections with TRACe1 are displayed as well. → Same as with HLD1, but the intersections with TRACe2 are displayed. → The deactivated cursor is no longer displayed.	2.10.2 **Softkey** F8 sel. o-cursor F9 sel. *-cursor → F6 (A,B) → F7 (A-B) → F8 (* - O) → F9 (HLINE) → A → F9 (HLINE) → B → F9 (HLINE) → ΔA → F9 (HLINE) → ΔB → F11 (ON/OFF)
DISPlay[:WINDow]:**TRAC**e[]:***CURS**or[1|2]:***POS**ition:***M**ODE	*MIN1* *MIN2* *I MAX1* *MAX1* *I MAX2* *MAX2* *MARKer1* *NEXTmarker* *VALue*		Changes the position of the specified cursor. → Sets cursor to the minimum of TRACe1. → Sets cursor to the maximum of TRACe2. → Sets cursor to calculated maximum of TRACe1 (with FFT only) → Sets cursor to maximum of TRACe1. → Sets cursor to calculated maximum of TRACe2 (with FFT only) → Sets cursor to maximum of TRACe2. → Sets cursor to value of 1st marker (FFT only). → Sets cursor to the next marker value (FFT only). → Sets cursor to the value specified with the command below.	2.10.2 **Softkey** F8 sel. O-CURS or *-CURS → F10 (SET TO) → ---- → ---- → F6 (I MAX A) → F7 (MAX A) → F8 (I MAX B) → F9 (MAX B) → F10 (MARKER) → F11 (NXTHARM)
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[1|2]:***POS**ition*	<nu>	3)	Sets specified cursor to the value of the X axis if DISPlay:TRACe[]:CURSor[1|2]:POSition:MODE VALue is set.	2.10.2 not via softkey

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[1|2]: *CURVe*	OFF ON		→ TRACe1: trace A on/off → TRACe2: trace B on/off	2.10.2 **Softkey** → F6 (CURVE) → F6 (A ON/OFF) → F7 (B ON/OFF)
DISPlay[:WINDow]:**TRAC**e[]:*ZOOM*	<n> 0 1 -1 2 3 4		 → Restores the original X axis defined by X AXIS LEFT and RIGHT. → Expands the display on the X axis by the factor 2 (can be repeated). → Reduces the display on the X axis by the factor 2 (repeated actions possible). → Shifts the center of the X axis of the new coordinates to the value of the o-cursors (CURSor1) without expanding the X axis. → The end points of the expanded X axis are determined by the X values of the two cursors → Cancels the last action.	2.10.2 **Softkey** F10 (ZOOM) → F10 (UNZOOM) → F6 (AT o UP) → F7 (ATo DOWN) → F8 (CEN TO o) → F9 (o TO *) → F11 (UNDO)
DISPlay[:WINDow]:**TRAC**e[1|2]:*MARKer*:**MODE**	 *MAXimum* *CURSor* *OFF*		Markers for FFT spectrum display → Sets the first marker to the maximum of TRACe1 or TRACe2. → Sets the first marker to the value defined by the o-cursor. TRACe1 or TRACe2 is used. → No markers	2.10.2 **Softkey** F11 (MARKER) F6 (TRACE A) or F7 (TRACE B). → MAX → CURSOR → VIEW OFF

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:**TRAC**e[1|2]:***MARK**er:**HARM**onics*	**ON** **OFF**		→ Sets markers for harmonics (frequency multiples) of MARKer1 (FFT only). Values marked in TRACe1 or TRACe2. → No harmonics markers.	2.10.2 **Softkey** F11 (MARKER) F6 (TRACE A) or F7 (TRACE B) → F10 (HARM) on/off
DISPlay[:WINDow]:**TRAC**e[]:***AUT**oscale*			Rescales the X and the TRACe1 axis. When active also the axis of TRACe2.	2.10.2 **Softkey** F7 (AUTOSCALE) F6 (ALL)
DISPlay[:WINDow]:**TRAC**e[]:***LAB**el*	**ON** **OFF**		→ Activates user title and units. → Deactivates user title and units.	2.10.2 **DISP panel** User Label → ON → OFF
DISPlay[:WINDow]:**TRAC**e:**X**:***LAB**el*	**"string"**		Specification of a string determining a user-definable label (unit and title) for the X axis.	2.10.2 **DISP panel** Unit/Label
DISPlay[:WINDow]:**TRAC**e**[1]**:**Y**:***LAB**el*	**"string"**		Specification of a string determining a user-definable label (unit and title) for the Y1 axis.	2.10.2 **DISP panel** Unit/Label
DISPlay[:WINDow]:**TRAC**e**2**:**Y**:***LAB**el*	**"string"**		Specification of a string determining a user-definable label (unit and title) for the Y2 axis.	2.10.2 **DISP panel** Unit/Label
DISPlay[:WINDow]:**TRAC**e[]:**IND**ex	**<n>** 1 to 17		Selects the nth single trace or curve pair. In the graphics display a circle marks the intersection of the vertical cursor line and the selected trace.	2.9.3.3 **Keys** PAGE UP / PAGE DOWN

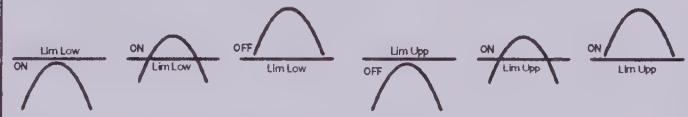
Command	Parameter	Basic unit	Meaning	Section
DISPlay:***CONF**iguration*			Configuration of screen display after switchover to LOCAL:	2.3.1
	P		→ Full-screen graphics display (plot)	
	SP		→ Status panel and graphics window	Keys / Ext. UPL keyboard
	AP		→ Analyzer panel and graphics window	
	GP		→ Generator panel and graphics window	
	FP		→ File panel and graphics window	GEN ALT+G
	DP		→ Display panel and graphics window	ANLR ALT+A
	OP		→ Options panel and graphics window	FILT ALT+T
	GAT		→ Generator, analyzer and filter panel	FILE ALT+F
	GAO		→ Generator, analyzer and options panel	DISP ALT+D
	GAD		→ Generator-, analyzer and display panel	GRAPH ALT+R
	FAT		→ File, analyzer and filter panel	ZOOM ALT+Z
	FAO		→ File, analyzer and options panel	SHOW I/O ALT+I
	FAD		→ File, analyzer and display panel	OPTIONS ALT+O
	SHON		→ Show IO graphics on	
	SHOFf		→ Show IO graphics off	
DISPlay[:WINDow]:**TRAC**e[]:***CURSor**[]:DATA1?* **DISP**lay[:WINDow]:**TRAC**e[]:***CURSor**[]:DATA2?* **DISP**lay[:WINDow]:**TRAC**e[]:***CURSor**[]:DATA3?*	Query only		Return the values of the cursor position. Depending on DISPlay:TRACe[]:CURSor[1|2]:MODE and DISPlay:TRACe:CURSor[1|2]ACTive the following values are available: DATA1 DATA2 DATA3 with CURSor1 and CURSor2 ACTive N12 A X B D12 A-B X - OFF - - - only with CURSor2 ACTive: C12 A-oA X-oX B-oB HL1 XAL y XAR HL2 XBL Y XBR HLD1 XAL A-Y XAR HLD2 XBL B-Y XBR	2.10.2 **Display in graphics window**

1) Depending on DISPlay:TRACe:FEED and (with SENSe1) of SENSe1:FUNCtion
2) Depending on the sweep selected for generator and analyzer
3) Same units as with DISPlay:TRACe[]:X:UNIT permitted.

3.10.6.1 Commands for Limit Check

See also Sections 2.10.7 Limit Check, 3.10.9 Commands for Input/Output of Data and 3.10.9 Commands for Input/Output of Data, for the transfer of limit curves and limit check results in the form of block data.

Command	Parameter	Basic unit	Meaning	Section
CALCulate:**LIM**it:*ON*	*TRACe1* *TRACe2* *TR1And2*		→ TRACe1 or bargraph 1 monitored. → TRACe2 or bargraph 2 monitored. → Both traces (bargraphs) monitored together.	2.10.7 **DISP panel** Check → TRACE A → TRACE B → TRACE A+B
CALCulate:**LIM**it:**UPP**er:**STAT**e	ON OFF		→ Upper limit monitoring switched on. → Upper limit monitoring switched off.	2.10.7 **DISP panel** LIMIT CHECK Mode → LIM UPPER Mode → OFF
CALCulate:**LIM**it:**UPP**er:**VAL**ue	<nu>	*)	Specifies a single upper limit value.	2.10.7 **DISP panel** Lim Upper → VALUE:
MMEMory:**LOAD:***LIST*	*LIMUpper*, "**filename**"		→ Defines a file containing the upper limit curve.	2.10.7 **DISP panel** Lim Upper → FILE + filenam"
CALCulate:**LIM**it:**LOW**er:**STAT**e	ON OFF		→ Lower limit monitoring switched on. → Lower limit monitoring switched off.	2.10.7 **DISP panel** LIMIT CHECK Mode → LIM LOWER Mode → OFF

Command	Parameter	Basic unit	Meaning	Section
CALCulate:**LIM**it:**LOW**er:**VAL**ue	**<nu>**	*)	Specifies a single lower limit value.	2.10.7 **DISP panel** Lim Lower → VALUE:
MMEMory:**LOAD:*LIST***	***LIML**ower,* **"filename"**		→ Defines a file containing the lower limit curve.	2.10.7 **DISP panel** Lim Lower → FILE + filename
CALCulate:**LIM**it:**FAIL?**	**<n>** Query only		Returns ON if Lim Upper values are exceeded or Lim Lower values are not attained, otherwise OFF. 	2.10.7 **No manual control**

*) Same units as with DISPlay:TRACe[1|2]:Y:UNIT permitted.

3.10.6.2 PROTOCOL Analysis

Command	Parameter	Basic unit	Meaning	Section
DISPlay:*PROTocol:SELect*	**LCHannel**status **RCHannel**status **LUS**erdata **RUS**erdata		Selects the protocol data of the AES/EBU interface to be displayed. → Left channel: status data → Right channel: status data → Left channel: user data → Right channel: user data	2.10.8 **DISP panel** Source → CHAN STAT L → CHAN STAT R → USER DATA L → USER DATA R
DISPlay:*PROTocol:FORMat*	**BIN**ary **HEX**adecimal **ASCii** **FILE**		Format selects the interpretation mode for user data. → User data displayed as 0101 sequence. → User data displayed as hexadecimal figures → User data displayed as plain text → Interpretation file for user data loaded with MMEMory:LOAD:PAU "filename".	2.10.8 **DISP panel** Format → BIN → HEX → ASCII → FILE DEF
MMEMory:LOAD:*PAU*	"**filename**"		Selects the interpretation file for user data if DISPlay:PROTocol:FORMat FILE has been set.	2.10.8 **DISP panel** Proto File
MMEMory:LOAD:*PAC*	"**filename**"		Selects the interpretation file for channel status data.	2.10.8 **DISP panel** Proto File
DISPlay:*PROTocol:ERRor:GENeral*?	Query only Response: UBB SQB NSYN PRMB SQLR RERR NONE		Query only Indicates errors occurred. "UBB" : unexpected preamble for beginning of block (too early) "SQB" : no preamble (blank) for beginning of block "NSYN" : no preamble for beginning of block "PRMB" : preamble invalid "SQLR" : error in the channel sequence (L/R) "RERR" : measured and set rate differ by more than 200 ppm "NONE" : no error	2.10.8 **GRAPH panel** **Display**

Command	Parameter	Basic unit	Meaning	Section
DISPlay:***PROT**ocol:**ERR**or:**PAR**ity**?**	Query only		Query only Displays the sum of all occurred parity errors. Zero reset by reselecting the analyzer or pressing the start key.	2.10.8 **GRAPH panel Display**
DISPlay:***PROT**ocol:**ERR**or:**LCRC**?**	Query only		Query only Internal counter of CRC errors (left)	2.10.8 **GRAPH panel Display**
DISPlay:***PROT**ocol:**ERR**or:**RCRC**?**	Query only		Query only Internal counter of CRC errors (right)	2.10.8 **GRAPH panel Display**
DISPlay:***PROT**ocol:**CHST**atus**?**	Query only NO LTC YES		Query only Indicates changes in the channel status data. "NO" : No changes "LTC" : Changes in local-time-code only (bits 112 to 143) and CRC (bits 184 to 191). "YES" : Changes at another bit position.	2.10.8 **GRAPH panel Display**
DISPlay:***PROTocol:LR?***	Query only EQUAL DIFF		Query only Channel status data between left and right channel are ... "EQUAL": same "DIFF" : different	2.10.8 **GRAPH panel Display**
DISPlay:***PROT**ocol:**LVAL**bit**?**	Query only Y0 N1		Query only Indicates the position of the validity bit in the left channel.	2.10.8 **GRAPH panel Display**
DISPlay:***PROT**ocol:**RVAL**bit**?**	Query only Y0 N1		Query only Indicates the position of the validity bit in the right channel.	2.10.8 **GRAPH panel Display**

3.10.7 Commands for Printing/Plotting of Screen and Storing in Files

Command	Parameter	Basic unit	Meaning	Section
HCOPy:DESTination	*PRSPc alias PRINter* *PLHPgl alias PLOTter* *PRPS* *PRHPgl*		Screen copy → to printer in the specified printer format (PRSPC = SPeCial printer format) → to plotter in HPGL format → to printer in PostScript format → to printer in HPGL format taking into account the content of the prolog file C:\UPL\REF\GL_PRO.LOG and the epilog file C:\UPL\REF\GL_EPI.LOG.	**2.14 OPTIONS panel** Destin (destination/format) → PRINTR/SPC → PLOTTR/HPGL → PRINTR/HPGL → PRINTR/PS → FILE/PCX → FILE/HPGL → FILE/PS → FILE/EPS
	FIPCx, 'filename.PCX' *alias* *PCXFile, 'name.PCX'*		→ to file in PCX format	
	FIHPgl, 'filename.GL' *alias* *HPGLfile, 'name.GL'*		→ to file in HPGL format	
	FIPS, 'filename.PS' *FIEPs, 'filename.EPS'*		→ to file in PostScript format → to file in Encapsulated PostScript format	
	For reasons of compatibility with existing programs the replys are as follows: PRIN PLOT PRHP PRPS PCXF HPGL FIPS FIEP			
HCOPy:DEVice:COLor	**ON**		→ PCX information stored in colours in the file specified by HCOP:DEST PCXFile, 'filename'.	**2.14 OPTIONS panel** COLOR → ON → OFF
	OFF		→ PCX information stored in black/white in the file specified by HCOP:DEST PCXFile, 'filename'.	

Command	Parameter	Basic unit	Meaning	Section
HCOPy:ITEM	*ALL* *GRATicule* *TRACe*		Effective only with HCOPy:DESTination PLOTter|HPGLfile → The complete screen is output, ie all labels and cursors as well as traces/bargraphs with scales. In the case of graphics windows the result display and a panel are output in addition. → Stores the traces/bargraphs with scales and scale labels but not the cursors and other labelling. → Only the trace(s) displayed is (are) transferred.	**2.14** **OPTIONS panel** Copy → SCREEN → CURVE/GRID → CURVE
HCOPy:ITEM:LABel:STATe	**ON** **OFF**		→ Hardcopy with comment → Hardcopy without comment	**2.14** **Key** H COPY or Ctrl F8
HCOPy:DEVice:*PRINter*	<n>		Effective only with HCOPy:DESTination PRINter Selects a printer driver. The number <n> to be specified for the desired printer driver can be obtained from the printer-driver box "List of installable Printers" opened under "Printname" in the OPTIONS panel.	**2.14** **OPTIONS panel** Printname
HCOPy:ITEM:FRAMe	*WHITe* *FDEFined*		Effective only with HCOPy:DESTination PRSPclFIPCxIPRPSIFIPSIFIEPs Selection of background colour of GRAPH panel frame and result panel for hardcopies on a printer or storage in a .PCX file. WHITE should be selected when the characters cannot be clearly distinguished on the grey background. → White → Colour defined via file For HCOP:DEST PRSPclFIPCx: Colour No. 2 (backgrnd frames) defined in files \UPD\REF\PRN_BW.PLT (BW printer) and \UPD\REF\PRN_CL.PLT (colour printer) is used. For HCOP:DEST PRPSIFIPSIFIEPs: The colour information for the frames of the GRAPH panel is taken from the PostScript configuration file \UPD\REF\PS.CFG, key word "Background Color" "Frame:" and "Plane:" and available as RGB information for colour PostScript pictures and as shades of grey for black/white PostScript pictures. Examples in file PS.CFG show the RGB combination for different background colours.	**2.14** **OPTIONS panel** Frame → WHITE → FILE DEF

Command	Parameter	Basic unit	Meaning	Section
HCOPy:*PLPort*	**COM2** **LPT1** **IEC**		Effective only with HCOPy:DESTination PLOTter → Hardcopy via serial interface 2. → Hardcopy via parallel printer interface. → Hardcopy via IEC/IEEE-bus interface.	**2.14** **OPTIONS panel** Plot on → COM 2 → LPT 1 → IEC BUS
HCOPy:*PLADdress*	<n>		Sets the IEC/IEEE-bus address of the plotter when HCOPy:DESTination PLOTer and HCOPy:PLPort IEC has been selected.	**2.14** **OPTIONS panel** → IEC Adr
HCOPy:**PAGE**:**LMAR**gin	<n> 0 to 80		Margin of hardcopy (number of spaces)	**2.14** **OPTIONS panel** LEFT MRGN
HCOPy:**DEV**ice:**RES**olution	***HIGH*** ***MED**ium* ***LOW***		Sets the printer resolution. Whether a resolution can be set and which one depends on the printer used. → High resolution (eg 300 dpi) → Medium resolution (eg 150 dpi) → Low resolution (eg 75 dpi)	**2.14** **OPTIONS panel** Prn Resol → HIGH → MEDIUM → LOW
HCOPy:**PAGE**:**SCAL**e:**X**	<n> 0.1 to 10		Scaling of X axis of hardcopy	**2.14** **OPTIONS panel** X-SCALING
HCOPy:**PAGE**:**SCAL**e:**Y**	<n> 0.1 to 10		Scaling of Y axis of screen hardcopy	**2.14** **OPTIONS panel** Y-SCALING
HCOPy:**PAGE**:**ORI**entation	**LAND**scape **PORT**trait		→ Hardcopy in upright format → Hardcopy in landscape format	**2.14** **OPTIONS panel** ORIENTATION → LANDSCAPE → PORTRAIT

Command	Parameter	Basic unit	Meaning	Section
HCOPy:PAGE:WIDTh?	Query only		Indicates the hardcopy width in cm. The width of a hardcopy depends on the following settings: - HCOPy:DEVice:PRINter (selected printer) - HCOPy:PAGE:SCALe:X (X scaling) - HCOPy:DEVice:RESolution (resolution)	**2.14** **OPTIONS panel** Prn Width,
HCOPy:PAGE:LENGth?	Query only		Indicates the hardcopy length in cm. The length of a hardcopy depends on the following settings: - HCOPy:DEVice:PRINter (selected printer) - HCOPy:PAGE:SCALe:Y (Y scaling) - HCOPy:DEVice:RESolution (resolution)	**2.14** **OPTIONS panel** Prn Height
HCOPy:SIZE	**A4** **LETTer**		Form feed for a screen copy in PostScript format → UPL images are optimally positioned on format A4 (21 cm * 29.6 cm). → UPL images are optimally positioned on format LETTER (21.6 cm * 27.9 cm).	**2.14** **OPTIONS panel** Paper Size → A4 → LETTER
HCOPy:PLOTs	**<n>** 1 to 6		Number of UPL plots to be printed on a PostScript page.	**2.14** **OPTIONS panel** Plots/Page
SYSTem:*PRINt*	***TRACe1*** ***TRACe2*** ***EQUalize*** ***ERRors*** ***DWELl*** ***LIMLower*** ***LIMUpper*** ***LIST1*** ***LIST2*** ***TR1And2*** ***OFF***		Printout of numerals in ASCII code (including X axis). → Printout of TRACe1. → Printout of TRACe2. → Printout of equalization values → Printout of values violating limits → Printout of timing values → Printout of lower limit values → Printout of upper limit values → X axis (eg sweep) → Z axis (eg sweep) → Printout of both traces → Switched off	2.14.5 **OPTIONS panel** PRINT------ Type → TRACE A → TRACE B → EQUALIZATN → LIM REPORT → DWELL → LIM LOWER → LIM UPPER → X AXIS → Z AXIS →TRACE A+B → OFF

Command	Parameter	Basic unit	Meaning	Section
HCOPy[:IMMediate]	Without parameter		Starts printout of the screen content Depending on command HCOP:DEST ... the current screen content is printed, plotted, or stored in a PCX or HPGL file or as a PostScript file, In the case of IEC/IEEE-bus and RS-232 control, only the result window and REMOTE are printed. A **remedy** is a HCOPY command with specified parameters which permits a hardcopy with preceding screen configuration to be printed.	**HCOPy** command via IEC/IEEE bus, RS-232 or Universal Sequence Controller UPL-B10

	CNF
	CF
	NCNF
	NCF
	CONFig
			With setting
			HCOPy:DESTination PRINter
			
			One of the four parameters CNF, CF, NCNF or NCF can be added to the HCOP command for printing the screen content with a comment:
			CNF: Hardcopy with comment*, without form feed
			CF: Hardcopy with comment*, with form feed
			NCNF: Hardcopy without comment, without form feed
			NCF: Hardcopy without comment, with form feed
			Thus a specific screen configuration (3-panel, split-screen or full-screen display) can be output to the printer via IEC/IEEE bus, RS-232 or through UPL-B10 control.
			The desired screen configuration has to be selected before with command DISP:CONF ... (see end of section 3.10.6, Commands for Graphical Display of Results).
			The HCOP command with one of the 4 parameters switches the UPL from REMOTE to manual control, builds up the screen with the selected configuration, scans the screen content and starts the hardcopy.
			The next IEC/IEEE-bus command switches the UPL back to the REMOTE mode.
			
			Program example:
			`:`
			`IECOUT 20,"HCOPy:DESTination PRINter"`
			`IECNREN:' Inhibits the LOCAL key ...`
			`IECREN:'... releases key blocking.`
			`IECOUT 20,"DISP:CONF GAT":' GEN, ANLR and FILTER panel`
			`IECOUT 20,"HCOP CF":' Triggers a hardcopy with comment`
			`'  and form feed`
			`IECLLO:' Reactivates blocking of the LOCAL key.`
			`:`	

Command	Parameter		Meaning	Section
Cont'd **HCOPy**[:IMMediate]	*CONFig*		Cont'd: **HCOPy:DESTination PRINter** If a screen copy without comment is output (HCOP:ITEM:LAB:STAT OFF), the desired screen configuration is first set with command DISP:CONF and then the HCOP command with parameter **CONF** is given. Program example: : **IECOUT 20,"HCOPy:DESTination PRINter"** **IECNREN:**' Inhibits the LOCAL key ... **IECREN:**'... releases key blocking. **IECOUT 20,"DISP:CONF GAT":**' GEN, ANLR and FILTER panel **IECOUT 20,"HCOP CONF":**' Trigg. a hcopy without comment **IECLLO:**' Reactivates blocking of the LOCAL key. :	**HCOPy** command via IEC/IEEE bus, RS-232 or Universal Sequence Controller UPL-B10
	CONFig		**With setting** **HCOPy:DESTination PCXFile,'filename':** The desired screen configuration has to be selected first with command DISP:CONF ... see end of section 3.10.6, Commands for Graphics Display of Results). The HCOP command with parameter **CONF** switches the UPL from REMOTE to manual control, builds up the screen with the selected configuration, scans the screen content and starts a hardcopy into the file. The next IEC/IEEE-bus command reset the UPL to the REMOTE mode. Program example: : **IECOUT 20,"HCOPy:DESTination PCXFile,'filename'"** **IECNREN:**' Inhibits the LOCAL key ... **IECREN:**'... releases key blocking **IECOUT 20,"DISP:CONF GAT":**' GEN, ANLR and FILTER panel **IECOUT 20,"HCOP CONF":**' Triggers a hardcopy without comment **IECLLO:**' Reactivates blocking of the LOCAL key. :	

Command	Parameter		Meaning	Section

Cont'd
HCOPy[:IMMediate]
	TITLe
	SUPPlement
			With settings
			HCOPy:DESTination PRPS
			HCOPy:DESTination FIPS, 'filename.PS'
			HCOPy:DESTination FIEPs, 'filename.EPS'
			
			A comment* can be added to the PostScript plot as a **TITLe** or caption (**SUPP**lement).
			
			Thus a specific screen configuration (3-panel, split-screen or full-screen display) can be output to the PostScript printer or a PostScript file via IEC/IEEE bus, RS-232 or through UPL-B10 control.
			A selection can be made with command HCOPy:ITEM ALL|GRAT|TRAC whether the whole screen content (ALL), only traces and scales (GRAT) or only traces (TRAC) are output as PostScript plot or stored in a PostScript file.
			When a hardcopy of traces is to be made (HCOP:ITEM GRAT|TRAC) make sure that the screen configuration selected with
			DISP:CONF PIS|PIA|PIG|PIF|PID|PIOP allows traces to be plotted.
			The HCOP command with one of the three parameters
			switches the UPL from the REMOTE to the manual control mode,
			builds up the selected configuration,
			scans the screen content and starts the hardcopy.
			The next IEC/IEEE-bus command resets the UPL to REMOTE.
			
			Program example:
			`:`
			`IECOUT 20,"HCOPy:DESTination FIPS, 'filename.PS'"`
			`IECNREN:' Inhibits the LOCAL key ...`
			`IECREN:'... disables key blocking.`
			`IECOUT 20,"DISP:CONF GAT":' GEN, ANLR and FILTER panel`
			`IECOUT 20,"HCOP TITL":' Triggers a hardcopy with a comment as a title`
			`IECLLO:' Reactivates blocking of the LOCAL key.`
			`:`
				HCOPy command via IEC/IEEE bus, RS-232 or Universal Sequence Controller UPL-B10

Command	Parameter		Meaning	Section
Cont'd **HCOP**y[:IMMediate]	**CONF**ig		Cont'd: **With settings** **HCOPy:DESTination PRPS** **HCOPy:DESTination FIPS, 'filename.PS'** **HCOPy:DESTination FIEPs, 'filename.EPS'** If a screen copy without comment (HCOP:ITEM:LAB:STAT OFF) is output, the desired screen configuration is first set with command DISP:CONF and then the HCOP command with parameter CONF is triggered. Program example: : IECOUT 20," HCOPy:DESTination FIPS, 'filename.PS' " IECNREN:' Inhibits the LOCAL key ... IECREN:'... disables key blocking. IECOUT 20,"DISP:CONF GAT":' GEN, ANLR and FILTER panel IECOUT 20,"HCOP CONF":' Trigg. a hcopy without comment IECLLO:' Reactivates blocking of the LOCAL key. :	**HCOP**y command via IEC/IEEE bus, RS-232 or Universal Sequence Controller UPL-B10

Command	Parameter		Meaning	Section

Cont'd
HCOPy[:IMMediate]
	CONFig		**With settings**
			HCOPy:DESTination PLOTter and
			HCOPy:DESTination PRHPgl
			HCOPy:DESTination HPGLfile,'filename':
			
			The default parameter **CONF** triggers a hardcopy to a plotter, a HPGL-compatible printer or a HPGL file with preceding screen configuration.
			A comment cannot be output.
			In addition to the screen configuration selected with DISP:CONF ... a selection can be made with command HCOPy:ITEM ALL|GRAT|TRAC whether the total screen content (ALL), only traces with scales (GRAT) or only traces (TRAC) are plotted or transferred to the HPGL file. When traces are to be plotted (HCOP:ITEM GRAT|TRAC) make sure that a screen configuration allowing traces to be plotted has been selected with DISP:CONF P|SP|AP|GP|FP|DP|OP.
			
			The HCOP command with one of the three parameters switches the UPL from REMOTE control to manual control, builds up the screen with the selected configuration,
			scans the screen content and starts the hardcopy.
			The next IEC/IEEE-bus command resets the UPL to REMOTE control.
			
			Program example:
			`:`
			`IECOUT 20,"HCOPy:DESTination PLOTter"`
			`IECNREN:' Inhibits the LOCAL key ...`
			`IECREN:'... releases key blocking.`
			`IECOUT 20,"DISP:CONF GAT":' GEN, ANLR and FILTER panel`
			`IECOUT 20,"HCOP CONF":' Triggers a hardcopy`
			`IECLLO:' Reactivates blocking of the LOCAL key.`
			`:`
			
			Note:
			No further HCOP command may be given while a hardcopy is being executed (printed), since a command would abort the printout.
				HCOPy command via IEC/IEEE bus, RS-232 or Universal Sequence Controller UPL-B10

Command	Parameter	Basic unit	Meaning	Section
HCOPy:WAIT			Starts the printout (see above) The next Basic command is not carried out before printing (with optimum speed) in the background is completed.	**No manual control**
HCOPy:ABORt			Aborts the hardcopy.	**2.14** **Key** H COPY or CTRL F8

3.10.8 Setting and Display of Auxiliary Parameters

3.10.8.1 IEC/IEEE-Bus Address

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**COMM**unicate:**GPIB:ADD**Ress	<n> 0 to 31		IEC/IEEE bus address of UPL	2.15.1 **OPTIONS panel** UPL IECadr

3.10.8.2 Switching the Beeper On/Off

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**BEEP**er:**STATe**	**ON** **OFF**		→ Beeper on → Beeper off	2.15.2 **OPTIONS panel** Beeper → ON → OFF

3.10.8.3 MACRO Operating

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**PROG**ram:**EXEC**ute	**'filename'**		By means of this command any BASIC program with the name <filename> (preferred file extension: *.BAS) can be loaded and started. After the program has been quit, a 1→0 transition is generated in the RUN bit (#14) of the operation register. This is communicated to the controller via SRQ or serial poll so that it can fetch the measurement results. Data exchange between the external control program and the BASIC program can be performed via the measurement-result displays, the measurement-result buffers or the block data input/output by adding on the command SYST:PROG **<n>{,<n>}**. For a detailed example see **3.15.18 Call BASIC-Macro**. Only in IEC/IEEE-bus or RS232-remote-control mode can a BASIC macro be started with this command. A program supplied by the Universal Autorun Control UPD-K1 **cannot** start a BASIC macro.	**2.16 OPTIONS-Panel** Exec Macro <filename>
SYSTem:**PROG**ram[:DATA]	**<n>{,<n>}**		Up to 1024 various floating-point values can be transferred to the external control program from a BASIC macro. To do this, the values are written to the block buffer by the BASIC macro and then read by the external control program. For a detailed example see **3.15.18 Call BASIC-Macro**	**No manual control**
SYSTem:**PROG**ram:**POIN**ts?	**<n>** 0 ... 1024 Query only		Number of the available block-data values written to the block buffer by the BASIC macro.	**No manual control**

3.10.8.4 Transfer of Settings

Command	Parameter	Basic unit	Meaning	Section
SYSTem:***PAR**ameter:**LINK***	<n> *) 0 to 2047		Permits transfer of settings in the generator or analyzer to another signal or measurement function or to another instrument.	**2.15.7 OPTIONS panel** Param. Link

*)

MSB										LSB	
d10	d9	d8	d7	d6	d5	d4	d3	d2	d1	d0	Datenbit
1024	512	256	128	64	32	16	8	4	2	1	Wertigkeit

Beispiel: Funktion von d0, d3, d9 und d10 ist gewünscht
Datenwort: 11000001001
Wertigkeit = 1+8+512+1024 = 1545
n =1545

- Beim Wechsel der Signalfunktion werden die Funktionseinstellungen mitgenommen.
- Beim Wechsel des Generatorinstruments wird die Output-Konfiguration mitgenommen.
- Beim Wechsel des Gen.-Instruments werden die Funktionen und deren Einstellungen mitgenommen.
- Beim Wechsel der Meßfunktion werden die Funktionseinstellungen mitgenommen.
- Beim Wechsel des Analysatorinstruments wird die Input-Konfiguration mitgenommen.
- Beim Wechsel des Analysatorinstruments werden die START COND-Einstellungen mitgenommen.
- Beim Wechsel des Analysatorinstruments werden die INPUT DISP-Einstellungen mitgenommen.
- Beim Wechsel des Analysatorinstruments werden die FREQ/PHASE-Einstellungen mitgenommen.
- nicht belegt
- Beim Wechsel des Anl.-Instruments werden die Funktionen und deren Einstellungen mitgenommen.
- Beim Wechsel der Signalfunktion wird die geeignete Meßfunktion eingestellt.

3.10.8.5 Parameters of COM2 Interface

The parameters to be set in this section apply to a screen printout on a plotter with COM2 interface selected.
(HCOP:DEST PLOT mit HCOP:PLP COM2).

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**COMM**unicate:**SER**ial2:**FEED**:**BAUD**	<n> n = **2400** **3600** **4800** **7200** **9600** **19200** **38400** **56000**		Transmission speed in baud (bits/s) (default setting: 9600)	**2.15.1** **OPTIONS panel** Baud Rate → 2400 Baud → 3600 Baud → 4800 Baud → 9600 Baud → 19200 Baud → 38400 Baud → 56000 Baud
SYSTem:**COMM**unicate:**SER**ial2:**FEED**:**PAR**ity[:TYPE]	**NONE** **EVEN** **ODD**		Parity check → Parity check off → Check for even parity (default setting) → Check for odd parity	**2.15.1** **OPTIONS panel** Parity → NONE → EVEN → ODD
SYSTem:COMMunicate:**SER**ial**2:FEED:BITS**	<n> n = 7 | 8		Number of data bits (default setting: 7)	**2.15.1** **OPTIONS panel** Data Bits → 7 → 8
SYSTem:COMMunicate:**GTL**			Return to manual operation. This command is only required in case of remote control via RS-232.	**LOCAL** **keystroke**
SYSTem:COMMunicate:**SER**ial**2:FEED:SBIT**s	<n> n = 1 | 2		Number of stop bits (default setting: 1)	**2.15.1** **OPTIONS panel** Stop Bits → 1 → 2

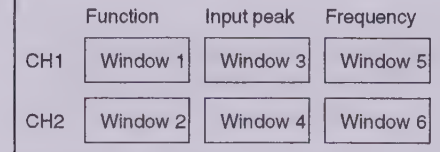
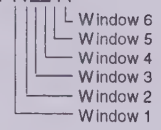
Command	Parameter	Basic unit	Meaning	Section
SYSTem:**COMM**unicate:**SER**ial2:**CONT**rol	**RTS** **XON**		Type of synchronization → Hardware handshake via RTS and CTS line (default setting) → Software handshake	**2.15.1** **OPTIONS panel** Handshake → RTS/CTS → XON/XOFF

3.10.8.6 Keyboard Settings

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**KEY:***RRAT*e	**<nu>** 0 to 50 Hz	Hz	Repetition rate of UPL and AT keyboard	2.15.3 **OPTIONS panel** Reptn Rate
SYSTem:**KEY:***RDEL*ay	**<nu>** 0.25 to 1.0 s	s	Response delay of UPL and AT keyboard	2.15.3 **OPTIONS panel** Rep Delay

3.10.8.7 Display Settings

Command	Parameter	Basic unit	Meaning	Section
DISPlay:**MODE**	*INTern* *COLBoth* *BWBoth* **AUTO**		→ Display on internal LCD → Additional display on external colour monitor → Additional display on external monochrome monitor → Additional display on external VGA monitor; the display mode (colour or monochrome) is adapted to the built-in LCD. The display is thus optimized for the built-in LCD so that the contrast quality will not be affected.	2.15.5 **OPTIONS panel** Extrn Disp → INTERN ONLY → BOTH COLOR → BOTH B/W → BOTH AUTO
DISPlay:***ANN**otation*[*:ALL*]	*ON* *OFF*		→ Display of measurement results and status → Result and status display cleared (FFT, sweep and IEC/IEEE-bus operation speeded up).	2.15.5 **OPTIONS panel** Meas Disp → ON → OFF Ext. Keyboard: CTRL D
DISPlay:***ACT**ualize*	*ON* *OFF*		This command may be called from Universal Autorun Control UPD-K1 or via the IEC/IEEE bus or by means of RS232 remote control. → Updates the graphics panel and repeats the update every time commands are output which change the graphics display in the UPL, eg DISPlay[:WINDow]:TRACe[]:X [:SCALe]:AUTO ON. → The graphics panel is not updated not even after commands changing the graphics display in the UPL. ***Note:*** *To enhance speed, it is best to **turn off the graphic when the remote-control mode is selected**. Graphics should only be activated when traces are to be displayed.*	**No manual control**

Command	Parameter	Basic unit	Meaning	Section
SYSTem:*DISP*lay:*READ*ing:*RATE*	***MAXS*peed** **FSTS**peed **MEDS**peed **SLWS**peed		Presetting for manual control. Determines the rate for the output of measured values in the result windows. The setting is only effective in the continuous measurement mode. In the case of sweeps and triggered measurements as well as with all measurements via IEC/IEEE bus, results are always output at maximum speed. → Max. output speed → 6 results/second → 3 results/second → 1 result/second	2.15.5 **OPTIONS panel** Read Rate → MAX SPEED → 6/s → 3/s → 1/s
SYSTem:*DISP*lay:*READ*ing:*RES*olution	<n>		Presetting for manual control. Sets the number of decimal digits for the display of measured values in the result windows. With measurements via IEC/IEEE bus results are always displayed with maximum resolution. Decimal digits for the 6 result windows are specified by 6 numbers between 0 and 6 (higher numbers are interpreted as 6). 0: Automatic display of decimal digits 1 to 6: 1 to 6 decimal digits Each number is assigned to a result window:  SYSTem:DISPlay:READing:RESolution 112244  Leading zeros may be omitted so that for <n> = 34, for example, the result in window 6 is displayed with 4 decimal digits, the result in window 5 with 3 and the results in windows 1 to 4 without any decimal digits at all.	2.15.5 **OPTIONS panel** Read Resol

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**DISP**lay:**TRAC**e[]:**LOAD**	**MAN**ual **DEF**ault **ACOL**or **ALIN**e		→ For each scan of a trace group (to be selected with the subsequent command SYST:DISP:TRAC[1|2]:SEL <n>) a colour and the line pattern can be selected for the display. → Automatic assignment of colour and line pattern to max. 17 scans for Trace A and Trace B. All scans of Trace A are green, those of Trace B yellow with thin continuous lines. → Automatic assignment of colour to 17 scans for Trace A and Trace B. → Automatic assignment of line pattern to 17 scans of Trace A and Trace B.	**2.15.5.4** **OPTIONS panel** Scan conf → MANUAL → DEFAULT → AUTO COLOR → AUTO LINE
SYSTem:**DISP**lay:**TRAC**e[1|2]:**SEL**ect	<n> 1 to17		Scan number of trace group to which a colour or line pattern is to be assigned with the two subsequent commands SYST:DISP:TRAC[1|2]:COL and SYST:DISP:TRAC[1|2]:LINE for screen display.	**2.15.5.4** **OPTIONS panel** Scannr.(A) Scannr.(B)
SYSTem:**DISP**lay:**TRAC**e[1|2]:**COL**or	**GRE**en **YELL**ow **BLUE** **CYAN** **MAG**enta **WHIT**e **BLAC**k **DGR**ay **LGR**ay		Assignment of colour to the scan number specified with command SYST:DISP:TRAC[1|2]:SEL <n> when colour display is selected. Shades of grey with monochrome display selected. Newly assigned colours are only visible on the screen after the LOCAL mode has been restored.	**2.15.5.4** **OPTIONS panel** Color (A) / (B) → GREEN → YELLOW → BLUE → CYAN → MAGENTA → WHITE → BLACK → DARK GRAY → LIGHT GRAY

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**DISP**lay:**TRAC**e[1|2]:**LINE**	**SSOL**id **SD** **SP** **SPD** **DSOL**id **DD** **DP** **DPD**		Line patterns for the scan number specified with command SYST:DISP:TRAC[1|2]:SEL <n>. → thin continuous line → dashed line → dotted line → dash-dot line → three-times-wide continuous line → dashed line → dotted line → dash-dot line The newly assigned line pattern is only visible on the screen after the LOCAL mode has been restored.	**2.15.5.4 OPTIONS panel** Line (A) / (B) → ———— → – – – – – → . . . . . . → .–.–.– → ═══ → = = = = = → : : : : : → :=:=:=

3.10.8.8 Version Display

Command	Parameter	Basic unit	Meaning	Section
SYSTem:*SOFTware*:*VERSion*?	*SOFTware* *SETUp* Query only Query: SYST:SOFT:VERS? SOFT SYST:SOFT:VERS? SETU The response is the number of a version (eg 3.05).		→ Version number of UPL software → Version number of setup	2.15.7 **OPTIONS panel** VERSIONS ------ Software Setup
SYSTem:*AHARdware*:*VERSion*?	*ABOard* *ACODe* Query only Query: SYST:AHAR:VERS? ABO SYST:AHAR:VERS? ACOD The response is either the number of a version (eg 0.01) or -NA- (Not Available) if the board is not installed.		→ Version number of analog board → Version number of generator source impedance with the BAL output selected: Query reply 0.00: generator source impedance 200 Ω (standard value) 0.01: generator source impedance 150 Ω with the standard generator source impedance changed from 200 Ω to 150 Ω using the Modification Analog Generator UPL-U3 (Order No. 1078.4900.02)	2.15.7 **OPTIONS panel** VERSIONS ------ Anlg Board code

Command	Parameter	Basic unit	Meaning	Section
SYSTem:*DHARdware:VERSion*?	***CPU**board* ***DBO**ard* Query only Query: SYST:DHAR:VERS? CPU SYST:DHAR:VERS? DBO The response is the number of a version (eg 0.05).		→ CPU board 3.86 I 4.86 (386-CPU, 486-CPU) → Version number of digital board	2.15.7 **OPTIONS panel** VERSIONS ------ **CPU board** Digl. Board
SYSTem:*OPTions:VERSion*?	*alias* ***LDG*** ***B1*** ***REMOte*** ***B4*** ***DAUDio*** ***B2*** ***SPEaker*** ***B5*** ***DAPRotocol*** ***B21*** ***DAJItter*** ***B22*** ***SQCOntrol*** ***B10*** ***B33*** ***B6*** The response is either the number of an option (eg 0.01), INST or -NA- (Not Available) if the board or option are not installed.		Version number of options → Low Distortion Generator (UPL-B1) → Remote Control (UPL-B4) → Digital Audio I/O (UPL-B2) → Audio Monitor (UPL-B5) → Digital Audio Protocol (UPL-B21) → Jitter and Interface Test (UPL-B22) → Universal Sequence Controller (UPL-B10) → Line measurement to ITU-T33 (UPL-B33) → Extended analyzer functions (UPL-B6)	2.15.7 2.6.6 **OPTIONS panel** OPTIONS ------- B1 Low Dist B4 Rem Ctrl B2 DigAudio B5 Speaker B21 DA Prot B22 DA Jitt B10 Seq Ctrl ITU-T O33 B6 Coher

3.10.8.9 Calibration

Command	Parameter	Basic unit	Meaning	Section
CALibrate:**LDG**:**AUTO**	**OFF** **ONCE**		→ No calibration of low-distortion generator → Triggers an automatic calibration of the low-distortion generator. This should be after one hour of operation at the earliest.	2.15.6 **OPTIONS panel** CALIBR. GEN LDG Auto → OFF → ONCE
CALibrate:**ZERO**:**AUTO**	**OFF** **ON** **ONCE**		→ No offset calibration → Offset calibration cyclic and after a change of analyzer/instrument. → Manual triggering of offset calibration; then reset to ON	2.15.6 **OPTIONS panel** CALIBR. ANL Zero Auto → OFF → ON → ONCE
CALibrate:**JITT**er:**AUTO**	**OFF** **ONCE**		→ No calibration of digital Phase to Ref measurement. → Manual triggering of automatic calibration of digital Phase to Ref measurement; then reset to OFF.	2.15.6 **OPTIONS panel** CALIBR. DIG PhaseToRef → OFF → ONCE
CALibrate	**OFF** **AUTO** **DCC** **LDG**		→ No offset calibration. Equivalent to CALibrate:ZERO:AUTO OFF. → Offset calibration cyclic and after a change of analyzer/instrument. Equivalent to CALibrate:ZERO:AUTO ON. → Manual triggering of offset calibration; then reset to AUTO. Equivalent to CALibrate:ZERO:AUTO ONCE. → Automatic calibration of low-distortion generator. This should be after one hour of operation at the earliest. Equivalent to CALibrate LDG:AUTO ONCE.	2.15.6

3.10.8.10 Loading Speed for Setups and Analyzer Measurement Functions

Command	Parameter	Basic unit	Meaning	Section
SYSTem:**LSP**eed	**FAST**		Speed for loading setups and analyzer measurement functions → Loading setups and analyzer functions can be speeded up while **FAST** is active. (considerably faster than SLOW), given the following minor restrictions: • During loading of setups and changing analyzer functions the graphics system is not initialized, IEC/IEEE-bus commands for the graphics systems have no effect and are rejected with an error message. K1 commands UPLGTLU und UPLGTLG cannot be used for graphic display (see section 3.16.4.3, Basic Extensions). • When analyzer measurement functions are changed, the currently set function is not stored, ie after switching back to the previously set function, the parameters of the slower mode (SYST:LSP SLOW) will be set. • When an *RST is performed, the output of measurement results is suppressed so as if the command DISP:ANN OFF were output. When the IEC/IEEE-bus is quit, (LOCAL key or IEC/IEEE-bus command GTL) the slower load mode is set without the above-mentioned restrictions.	**No manual operation**
	SLOW		→ without restrictions, therefore slower than FAST (default setting).	

3.10.9 Commands for Data Output

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]:DATA1|2?	Query only	Depending on FUNC	Returns the measured value of the 1st analyzer for RMS, RMSS, PEAK, QPE, DC, THD, THDN, MDIST, DFD and WAF functions. DATA1 selects input channel 1 DATA2 selects input channel 2.	3.15.8 **No manual control** **Result display**
SENSe2:DATA1|2?	Query only	V/FS	Returns the measured value of the 2nd analyzer (peak voltage meter). DATA1 selects input channel 1 DATA2 selects input channel 2.	3.15.8 **No manual control** **Result display**
SENSe3:DATA1|2?	Query only	Hz	Returns the measured value of 3rd analyzer (frequency counter). DATA1 selects input channel 1 DATA2 selects input channel 2.	3.15.8 **No manual control** **Result display**
SENSe4:DATA?	Query only	DEG	Returns the measured value of the 4th analyzer (phase meter).	3.15.8 **No manual control** **Result display**

Write access to the measurement-result buffers is also possible with Universal Autorun Control (UPD-K1) or remote control (IEC/IEEE bus interface). This is of particular interest for operation with BASIC macros:

- The measurement results calculated by a BASIC macro can be displayed in the usual measurement-result window.
- Any floating-point parameters and measurement results may be exchanged between the BASIC macro and the controller via the measurement-result buffers.

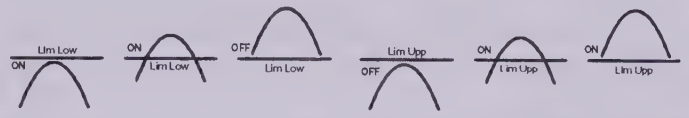
For a detailed example see 3.15.18 Call BASIC-Macro.

3.10.10 Commands for Input/Output of Block Data

Command	Parameter	Basic unit	Meaning	Section
FORMat[:DATA]	**ASCI**i **REAL**		→ Determines the numeric format for block data only. Output of numbers with sign, point and possibly exponent (default). → Determines the numeric format for block data only. Output in binary form. This setting is not stored in the setup and set to ASCII each time the UPL is switched on.	2.9.1.2 **No manual control**
SENSe[1]:**LIST:FREQ**uency **SOURce:LIST:FREQ**uency	<n>{,<n>} <n>{,<n>}	Hz	These two commands are identical and specify the block data for a frequency sweep or frequencies for a sequence of measurements. When limit or equalization curves are specified, the frequencies are to be sorted in ascending or descending order.	2.9.1.3 **No manual control**
SENSe[1]:**LIST:FREQ**uency:**POIN**ts? **SOURce:LIST:FREQ**uency:**POIN**ts?	<n> 0 to 1023 Query only		The two commands are identical and return the number of currently available block data for the frequency axis.	2.9.1.3 **No manual control**
SOURce:LIST:VOLTage	<n>{,<n>}	V	Specifies the block data for a voltage sweep or the output voltage for a sequence of measurements.	2.9.1.3 **No manual control**
SOURce:LIST:VOLTage:**POIN**ts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the voltage axis.	2.9.1.3 **No manual control**
SOURce:LIST:*ONTime*	<n>{,<n>}	S	Specifies the block data for a sweep of the on-time and off-time ratio of the burst signal or of a sequence of measurements.	2.9.1.3 **No manual control**
SOURce:LIST:*ONTime*:**POIN**ts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the on-time axis.	2.9.1.3 **No manual control**
SOURce:LIST:*INTerval*	<n>{,<n>}		Specifies the block data for a sweep of the on-time to off-time ratio of the burst signal or a sequence of measurements.	2.9.1.3 **No manual control**

Command	Parameter	Basic unit	Meaning	Section
SOURce:LIST:*INTerval*:POINts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the interval axis.	2.9.1.3 **No manual control**
SOURce:LIST:DWELl	<n>{,<n>}	s	Specifies the block data for the dwell time of a sweep or a measurement sequence.	2.9.1.3 **No manual control**
SOURce:LIST:DWELl:POINts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the dwell time.	2.9.1.3 **No manual control**
SOURce:LIST:DWELl:CONTrol[:DATA]	<n>{,<n>}		X axis for the dwell time.	2.9.1.3 **No manual control**
SOURce:LIST:DWELl:CONTrol:POINts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the dwell time.	2.9.1.3 **No manual control**
SOURce:VOLTage:EQUalize[:DATA]	<n>{,<n>}		Specifies the block data for the voltage axis of the equalization curve.	2.9.1.3 **No manual control**
SOURce:VOLTage:EQUalize:POINts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the voltage equalization list.	2.9.1.3 **No manual control**
SOURce:EQUalize:CONTrol[:DATA]	<n>{,<n>}		Specifies the block data for the frequency axis of the equalization curve.	2.9.1.3 **No manual control**
SOURce:EQUalize:CONTrol:POINts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the frequency axis of the equalization curve.	2.9.1.3 **No manual control**

Command	Parameter	Basic unit	Meaning	Section
CALCulate:**LIM**it:**UPP**er[:DATA]	<n>{,<n>}	1)	Specifies the block data for the Y axis of the upper limit curve.	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**UPP**er:**TRAC**e	<n>{,<n>}		Returns the block data for the y axis of the **upper** limit trace interpolated along the x axis. The command `trac:points? list1` gives the number of x values, which were used for interpolation. It is the same as the number of interpolated y values for the **upper** limit trace.	2.9.1.3 **Keine Handbedienung**
CALCulate:**LIM**it:**UPP**er:**POIN**ts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the Y axis of the upper limit curve.	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**UPP**er:**CONT**rol[:DATA]	<n>{,<n>}		Specifies the block data for the X axis of the limit curves	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**UPP**er:**CONT**rol:**POIN**ts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the X axis of the limit curves.	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**LOW**er[:DATA]	<n>{,<n>}	1)	Specifies the block data for the Y axis of the lower limit curve.	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**LOW**er:**TRAC**e	<n>{,<n>}		Returns the block data for the y axis of the **lower** limit trace interpolated along the x axis. The command `trac:points? list1` gives the number of x values, which were used for interpolation. It is the same as the number of interpolated y values for the **lower** limit trace.	2.9.1.3 **Keine Handbedienung**
CALCulate:**LIM**it:**LOW**er:**POIN**ts?	<n> 0 to 1023 Query only		Returns the number of currently available block data for the Y axis of the lower limit curve.	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**LOW**er:**CONT**rol[:DATA]	<n>{,<n>}		Specifies the block data for the X axis of the limit curves.	2.9.1.3 **No manual control**

Command	Parameter	Basic unit	Meaning	Section
CALCulate:**LIM**it:**LOW**er:**CONT**rol:**POIN**ts?	<n> Query only		Returns the number of currently available block data for the X axis of the limit curves.	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**FAIL**?	Query only		Returns ON if Lim Upper values are exceeded or Lim Lower values are not attained, otherwise OFF. 	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**REP**ort[:DATA]?	<n>{,<n>}Query only		Returns the block data of limit violations. Corresponds to the contents of a Limt Report file as described in section 2.9.1.2 Loading and Storing of Series of Measured Values and Block/List Data	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**REP**ort:**POIN**ts?	<n> 0 to 1023 Query only		Returns the number of currently available block data of limit violations.	2.9.1.3 **No manual control**
TRACe[:DATA]	**TRACe1, <n>**{,<n>} Query: TRACe? TRACe1	1)	Specifies the block data of the first measurement sequence (Y1 axis).	2.9.1.3 **No manual control**
TRACe:**POIN**ts?	**TRACe1** Query only Query: TRAC:POIN? TRAC1 Query reply <n> = 0 to 1023		Returns the number of currently available block data of the first measurement sequence (Y1 axis).	2.9.1.3 **No manual control**
TRACe[:DATA]	**TRACe2, <n>**{,<n>} Query: TRACe? TRACe2	1)	Specifies the block data of the second measurement sequence (Y2 axis).	2.9.1.3 **No manual control**

Command	Parameter	Basic unit	Meaning	Section
TRACe:POINts?	**TRACe2,** Query only Query: TRAC:POIN? TRAC2 Query reply <n> = 0 to 1023 Query only		Returns the number of the currently available block data of the second measurement sequence (Y2 axis).	2.9.1.3 **No manual control**
TRACe[:DATA]	**LIST1, <n>{,<n>}** Query: TRACe? LIST1	2)	Specifies the block data of the first sweep list (X axis).	2.9.1.3 **No manual control**
TRACe:POINts?	**LIST1 <n>** Query only Query: TRAC:POIN? LIST1 Query reply <n> = 0 to 1023 Query only		Returns the number of the currently available block data of the first sweep list (X axis).	2.9.1.3 **No manual control**
TRACe[:DATA]	**LIST2, <n>{,<n>}** Query: TRACe? LIST2	2)	Specifies the block data of the second (convoluted, nested) sweep list (Z axis).	2.9.1.3 **No manual control**
TRACe:POINts?	**LIST2** Query only Query: TRAC:POIN? LIST2 Query reply <n> = 0 to 1023		Returns the number of the currently available block data of the second (convoluted, nested) sweep list (Z axis).	2.9.1.3 **No manual control**
TRACe[:DATA]	**REFerence1,<n>{,<n>}** Query: TRACe? REF1		Loads the running reference values for the Y axis.	2.9.1.3 **No manual control**

Command	Parameter	Basic unit	Meaning	Section
TRACe:POINts?	**REF**erence1 Query only Query: TRAC:POIN? REF1 Query reply <n> = 0 to 1023		Returns the number of the currently available block data for the Y axis of trace A.	2.9.1.3 **No manual control**
TRACe[:DATA],	**REF**erence**2**,**<n>**{,**<n>**} Query: TRACe? REF2		Loads the running reference values for the Y axis of trace B	2.9.1.3 **No manual control**
TRACe:POINts?	**REF**erence**2** Query only Query: TRAC:POIN? REF2 Query reply <n> = 0 to 1023		Returns the number of the currently available block data for the Y axis of trace B.	2.9.1.3 **No manual control**
TRACe[:DATA],	**CREF**erence**1**,**<n>**{,**<n>**} Query: TRACe? CREF1		Loads the running reference values for the X axis of trace A.	2.9.1.3 **No manual control**
TRACe:POINts?	**CREF**erence1 Query only Query: TRAC:POIN? CREF1 Query reply <n> = 0 to 1023		Returns the number of the currently available block data for the X axis of trace A.	2.9.1.3 **No manual control**
TRACe[:DATA]	**CREF**erence**2**,**<n>**{,**<n>**} Query: TRACe? CREF2		Loads the running reference values for the X axis of trace B	2.9.1.3 **No manual control**

Command	Parameter	Basic unit	Meaning	Section
TRACe:POINts?	**CREF**erence**2** Query only Query: TRAC:POIN? CREF2 Query reply <n> = 0 to 1023		Returns the number of the currently available block data for the X axis of trace B.	2.9.1.3 **No manual control**

1) Depending on DISPlay:TRACe:FEED and (with SENSe1:DATA) of SENSe1:FUNCtion
2) Depending on sweep selected for generator and analyzer.

3.10.11 Commands for Status and Error Queries

Command	Parameter	Basic unit	Meaning	Section
STATus:**PRES**et			Resets the Enable registers of the OPERation, QUEStionable and XQUEstionable registers to 0. See 3.7.5 Resetting the Status Reporting Systems.	3.7.5 **No manual control**
STATus:**OPER**ation:**COND?**	Query only		Outputs the contents of the CONDition register as a decimal number (current value of Operating Status of UPL). For the weighting of the individual bits see 3.7.3.4 STATus:OPERation Register Reading out does not clear the register.	3.7.3.4 **No manual control**
STATus:**OPER**ation[:EVENt]**?**	Query only		Outputs the content of the EVENt register as a decimal number. A bit set in the EVENt register indicates a change of the corresponding bit in the CONDition register. The entry in the PTRansition and NTRansition registers determines whether a bit transition from 0 to 1 or from 1 to 0 causes an entry in the EVENt register. Reading out clears the register!	3.7.3.4 **No manual control**
STATus:**OPER**ation:**ENAB**le	**<n>** .... 0 0 1 0 0 1 0 0 ... .d7 d6 d5 d4 d3 d2 d1 d0 Example: d2 and d5 set: **<n>** = 36 (4 + 32)		Sets the ENABle mask which validates a bit in the EVENt register. Example: When d5 is set in the ENABle mask, the "Waiting for Trigger" event is set in the EVENt register provided the bit has changed. Dafault setting: every bit reset (0)	3.7.3.4 **No manual control**
STATus:**OPER**ation:**PTR**ansition	**<n>**		If a bit is set in the PTRansition register, the transition from 0 to 1 of the corresponding bit in the CONDition register causes 1 to be entered in the corresponding bit of the EVENt register provided the corresponding bit in the ENABle mask is set. Default setting: every bit reset (65535 or 0xFFFF)	3.7.3.4 **No manual control**

Command	Parameter	Basic unit	Meaning	Section
STATus:**OPER**ation:**NTR**ansition	<n>		If a bit is set in the NTRansition register, a transition from 1 to 0 of the corresponding bit in the CONDition register causes 1 to be entered in the corresponding bit of the EVENt register provided the corresponding bit in the ENABle mask is set. Default setting: every bit reset (65535 or 0xFFFF)	3.7.3.4 **No manual control**
STATus:**QUES**tionable:**COND?**	Query only		Outputs the status of the CONDition register (current value of Questionable Status of UPL) as a decimal number. For the weighting of the individual bits see 3.7.3.5 STATus:QUEStionable Register. Reading out does not clear the register.	3.7.3.5 **No manual control**
STATus:**QUES**tionable[:EVENt]**?**	Query only		Outputs the contents of the EVENt register as a decimal number. A bit set in the EVENt register indicates a change of the corresponding bit in the CONDition register. The entry in the PTRansition and NTRansition registers determines whether a bit transition from 0 to 1 or from 1 to 0 causes an entry in the EVENt register. Reading out clears the register!	3.7.3.5 **No manual control**
STATus:**QUES**tionable: **ENAB**le	<n>		See above.	3.7.3.5 **No manual control**
STATus:**QUES**tionable: **PTR**ansition	<n>		See above.	3.7.3.5 **No manual control**
STATus:**QUES**tionable: **NTR**ansition	<n>		See above.	3.7.3.5 **No manual control**
STATus:**XQUE**stionable:**COND?**	Query only		Outputs the content of the CONDition register as a decimal number (current value of XQuestionable Status of UPL). For the weighting of individual bits see 3.7.3.6 STATus:XQUEStionable Register. Reading out does not clear the register.	3.7.3.6 **No manual control**

Command	Parameter	Basic unit	Meaning	Section
STATus:**XQUE**stionable[:EVENt]**?**	Query only		See above.	3.7.3.6 **No manual control**
STATus:**XQUE**stionable: **ENAB**le	<n>		See above.	3.7.3.6 **No manual control**
STATus:**XQUE**stionable: **PTR**ansition	<n>		See above.	3.7.3.6 **No manual control**
STATus:**XQUE**Stionable: **NTR**ansition	<n>		See above.	3.7.3.6 **No manual control**
SYSTem:**VERS**ion**?**	Query only		Returns the number of the associated SCPI version by specifying the year with decimal point and one decimal digit.	2.15.7 **No manual control**
SYSTem:**ERR**or**?**	Query only		Returns the last error message out of the error message queue. Error messages consist of a number followed by text. Negative error numbers are SCPI-defined, positive numbers are device-specific. If no error occurred, the output is **0, "No error"** If the queue gets too long, the error message: **-350, "Queue overflow"** is output. With *CLS and upon power-on of the device, all error messages are cleared.	3.3.2 **No manual control**
SYSTem:**COMM**unication:**GTL**			Return to manual operation. This command is only required in the case of remote-control via the RS-232 interface but can also be used for IEC/IEEE-bus operation and Universal Sequence Controller UPL-B10.	LACAL keystroke

3.10.12 Commands for Synchronization

Command	Parameter	Basic unit	Meaning	Section
INITiate:**CONT**inuous	ON OFF		→ Presetting of continuous measurement. → Presetting of a single measurement which is triggered with INITiate[:IMMediate] (see next command)!	2.11 **START key** **SINGLE key**
INITiate[:IMMediate]			Starts a single measurement. Command INITiate:CONTinuous ON|OFF determines whether it is a continuous or a single measurement (see previous command). The two INITiate commands simulate the function of the START or SINGLE key. The following commands are to be entered: START key: INITiate:CONTinuous ON, INITiate[:IMMediate] SINGLE key: INITiate:CONTinuous OFF, INITiate[:IMMediate]	2.11 **START key** **SINGLE key**
Command	**Parameter**	**Basic unit**	**Meaning**	**Section**
INITiate:***FORC**e*	***STAR**t* ***SING**le* ***STOP*** ***CONT**inuous*		→ • A measurement in progress is immediately aborted. • Trailing pointer, average and peak values are reset. • A new continuous measurement is started. (identical with command "INIT:CONT ON") → • A measurement in progress is immediately aborted. • A new measurement is started. (identical with command INIT:CONT OFF) → An ongoing measurement is stopped as if the STOP/CONT key was pressed during the measurement. (identical with command ABORt). The measurement is continued with INIT:FORC CONT. → • A new continuous measurement is started. • Trailing pointer, average and peak values are **not** reset. This is only effective if the measurement was interrupted with INIT:FORC STOP or ABOR or if the measurement was started with INIT:FORC SING or INIT:CONT OFF and completed.	**2.11** → **Taste START** → **Taste SINGLE** → STOP function of toggel key **STOP/CONT** → CONT function of toggel key **STOP/CONT**

Command	Parameter	Basic unit	Meaning	Section
INITiate:**NEXT**	<n>		Has the same effect as turning the spinwheel by <n> steps or pressing the cursor keys (n=1 or n= –1). Makes the next step in the case of a manual sweep or moves the graphics cursor provided the graphics panel is active.	2.11 **Spinwheel**
ABORt			Stops a measurement as if the STOP/CONT key were actuated during an ongoing measurement. With the command INIT:CONT ON the measurement is resumed.	2.11 **STOP/CONT key**

3.10.13 Settings without Corresponding IEC/IEEE-Bus Command

- Setting the contrast for UPL monochrome display
- Selection of remote control in the OPTIONS panel with remote via IEC/COM2

3.11 Alphabetical List of IEC/IEEE-Bus Commands

Command	Parameter	Section
ABORt		**2.11** **Taste** **STOP/CONT**
ARM:FREQuency:**STAR**t **ARM:FREQ**uency:**STOP**	**<nu>** Value range determined by instrument or function	**2.6.4** **ANLR-Panel** Start | Stop
ARM:LEVel:**MIN**	**<nu>** Analog instruments 10 mV to 1000 V Digital instrument 1µFS to 1.0 FS	**2.6.4** **ANLR-Panel** Min VOLT
ARM:VOLTage:**STAR**t **ARM:VOLT**age:**STOP**	**<nu>** Analog instruments 10 mV to 1000 V Digital instrument 1 mFS to 1.0 FS	**2.6.4** **ANLR-Panel** Start | Stop
CALCulate:**EQU**alize:**FEED**	**TRACe1** **TRACe2**	**2.9.1.2** **FILE-Panel** Volt Source → TRACE A → TRACE B
CALCulate:**EQU**alize:**INV**ert	**ON** **OFF**	**2.9.1.2** **FILE-Panel** Invert 1/n → ON → OFF
CALCulate:**EQU**alize:**NORM**freq	**<nu>** f_{min} ··· f_{max}	**2.9.1.2** **FILE-Panel** Norm Freq
CALCulate:**LIM**it:**FAIL?**	**<n>** Query only	**2.10.7** **keine Handbedienung**
CALCulate:**LIM**it:**LOW**er:**CONT**rol:**POIN**ts?	**<n>** Query only	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**LOW**er:**CONT**rol[:DATA]	**<n>**{,**<n>**}	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**LOW**er:**POIN**ts?	**<n>** 0 to 1023 Query only	**2.9.1.3** **No manual control**

Command	Parameter	Section
CALCulate:**LIM**it:**LOW**er:**STAT**e	**ON** **OFF**	**2.10.7** **DISP-Panel** LIMIT CHECK Mode → LIM LOWER → OFF
CALCulate:**LIM**it:**LOW**er:**TRAC**e	<n>{,<n>}	2.9.1.3 **No manual control**
CALCulate:**LIM**it:**LOW**er:**VAL**ue	<nu>	**2.10.7** **DISP-Panel** Lim Lower → VALUE:
CALCulate:**LIM**it:**LOW**er[:DATA]	<n>{,<n>}	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**ON**	**TRACe1** **TRACe2** **TR1And2**	**2.10.7** **DISP-Panel** Check → TRACE A → TRACE B → TRACE A+B
CALCulate:**LIM**it:**REP**ort:**POIN**ts?	<n> 0 to 1023 Query only	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**REP**ort[:DATA]?	<n>{,<n>} Query only	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**UPP**er:**CONT**rol:**POIN**ts?	<n> 0 to 1023 Query only	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**UPP**er:**CONT**rol[:DATA]	<n>{,<n>}	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**UPP**er:**POIN**ts?	<n> 0 to 1023 Query only	**2.9.1.3** **No manual control**
CALCulate:**LIM**it:**UPP**er:**STAT**e	**ON** **OFF**	**2.10.7** **DISP-Panel** LIMIT CHECK Mode → LIM UPPER Mode → OFF
CALCulate:**LIM**it:**UPP**er:**TRAC**e	<n>{,<n>}	2.9.1.3 **No manual control**

Command	Parameter	Section
CALCulate:**LIM**it:**UPP**er:**VAL**ue	**<nu>**	**2.10.7** **DISP-Panel** Lim Upper → VALUE:
CALCulate:**LIM**it:**UPP**er[:DATA]	**<n>**{,**<n>**}	**2.9.1.3** **No manual control**
CALCulate:**TRAN**sform:**FREQ**uency:**AVER**age	**<n>** 1 to 256	**2.6.5.12** **ANLR-Panel** Average
CALCulate:**TRAN**sform:**FREQ**uency:**AVER**age:**TCON**trol	**NORM**al **EXP**onential	**2.6.5.12** **ANLR-Panel** Avg Mode → NORMAL → EXPONENTIAL
CALCulate:**TRAN**sform:**FREQ**uency:**CENT**er	**<nu>** Value range determined by instrument or function	**2.6.5.12** **ANLR-Panel** Center
CALCulate:**TRAN**sform:**FREQ**uency:**FFT**	**S256** **S512** **S1K** **S2K** **S4K** **S8K**	**2.6.5.12** **ANLR-Panel** FFT Size → 256 → 512 → 1024 → 2048 → 4096 → 8192
CALCulate:**TRAN**sform:**FREQ**uency:**MTIM**e?	**<nu>** Query only	**2.6.5.12** **ANLR-Panel** Meas Time
CALCulate:**TRAN**sform:**FREQ**uency:**RES**olution?	**<nu>** Query only	**2.6.5.12** **ANLR-Panel** Resolution
CALCulate:**TRAN**sform:**FREQ**uency:**SPAN?**	**<nu>** Query only	**2.6.5.12** **ANLR-Panel** Span
CALCulate:**TRAN**sform:**FREQ**uency:**STAR**t? **CALC**ulate:**TRAN**sform:**FREQ**uency:**STOP?**	**<nu>** Query only	**2.6.5.12** **ANLR-Panel** Start / Stop
CALCulate:**TRAN**sform:**FREQ**uency:**STAT**e	**OFF** **ON**	**2.6.5.1** **ANLR-Panel** POST FFT → OFF → ON

Command	Parameter	Section
DISPlay:**PROT**ocol:**ERR**or:**RCRC?**	<n> Query only	**2.10.8** **GRAPH-Panel** **Display**
DISPlay:**PROT**ocol:**FORM**at	**BIN**ary **HEX**adecimal **ASCii** **FILE**	**2.10.8** **DISP-Panel** Format → BIN → HEX → ASCII → FILE DEF
DISPlay:**PROT**ocol:**LR?**	Query only Response:: **EQUAL** **DIFF'**	**2.10.8** **GRAPH-Panel** **Display**
DISPlay:**PROT**ocol:**LVAL**bit**?**	Query only Response:: **Y0** **N1**	**2.10.8** **GRAPH-Panel** **Display**
DISPlay:**PROT**ocol:**RVAL**bit**?**	Query only Response:: **Y0** **N1**	**2.10.8** **GRAPH-Panel** **Display**
DISPlay:**PROT**ocol:**SEL**ect	**LCH**annelstatus **RCH**annelstatus **LUS**erdata **RUS**erdata	**2.10.8** **DISP-Panel** Source → CHAN STAT L → CHAN STAT R → USER DATA L → USER DATA R
DISPlay[:WINDow]:**TEXT**:**LOC**ate	<ny>[,<nx>]	**2.10.1** **DISP-Panel** X Pos, Y Pos
DISPlay[:WINDow]:**TEXT**[:DATA]	**'string'**	**2.10.1** **DISP-Panel** COMMENT
DISPlay[:WINDow]:**TRAC**e:**X**:**LAB**el	**'string'**	**2.10.2** **DISP-Panel** Unit/Label
DISPlay[:WINDow]:**TRAC**e[]:**AUT**oscale alias **AUTO**scale		**2.10.2** **Softkey** F7 (AUTOSCALE) → F6 (ALL)
DISPlay[:WINDow]:**TRAC**e[]:**COUN**t	<n> aufgenommen: 1...100 000 gespeichert: max. 17 Kurven	**2.10** **DISP-Panel** Scan Count

Command	Parameter	Section
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[]:**DATA1?** **DISP**lay[:WINDow]:**TRAC**e[]:**CURS**or[]:**DATA2?** **DISP**lay[:WINDow]:**TRAC**e[]:**CURS**or[]:**DATA3?**	Query only	**2.10.2** **Display in graphics window**
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[1]:**MODE**	**N12** **D12** **OFF**	**2.10.2** **Softkey** F8: sel. O-CURS. F9: (O-CURSOR) → F6 (A,B) → F7 (A-B) → F11 (ON/OFF)
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[1|2]	**ACT**ive	**2.10.2** **DISP-Panel** Softkey level 1 F8
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[1|2]:**POS**ition	**<nu>**	**2.10.2** nicht über Softkey bedienbar
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or[1|2]:**POS**ition:**MODE**	**MIN1** **MIN2** **I MAX1** **MAX1** **I MAX2** **MAX2** **MARK**er1 **NEXT**marker **VAL**ue	**2.10.2** **Softkey** F8 sel. O-CURS or *-CURS. → F10 (SET TO) → ---- → ---- → F6 (I MAX A) → F7 (MAX A) → F8 (I MAX B) → F9 (MAX B) → F10 (MARKER) → F11 (NXT HARM)
DISPlay[:WINDow]:**TRAC**e[]:**CURS**or2:**MODE**	**N12** **D12** **C12** **HL1** **HL2** **HLD1** **HLD2** **OFF**	**2.10.2** **Softkey** F8 sel. O-CURSOR F9 sel. *-CURSOR → F6 (A,B) → F7 (A-B) → F8 (* - O) → F9 (HLINE) → A → F9 (HLINE) → B → F9 (HLINE) → ΔA → F9 (HLINE) → ΔB → F11 (ON/OFF)
DISPlay[:WINDow]:**TRAC**e[]:**IND**ex	**<n>** 1...17	**2.9.3.3** **Tasten** PAGE UP / PAGE DOWN

Command	Parameter	Section
DISPlay[:WINDow]:**TRAC**e[]:**LAB**el	**ON** **OFF**	**2.10.2** **DISP-Panel** User Label → ON → OFF
DISPlay[:WINDow]:**TRAC**e[]:**MODE**	**DEL**ete_bef_wr **WAT**erfall|**CASC**ade **MAXH**old	**2.10** **DISP-Panel** Mode → DEL BEF WR → WATERFALL → MAX HOLD
DISPlay[:WINDow]:**TRAC**e[]:**OPER**ation	**CURV**eplot **LIST** alias **TLIS**t **ERR**ors **BARG**raph **SPEC**trum **FFTL**ist **FFTE**rrors **PROT**ocol	**2.10** **DISP-Panel** OPERATION → CURVE PLOT **2.10.2** → SWEEP LIST **2.10.4** → SWP LIM REP **2.10.4** → BARGRAPH **2.10.2** → SPECT LIST **2.10.8** → SPC LIM REP **2.10.6** PROTOCOL
DISPlay[:WINDow]:**TRAC**e[]:**X**:**SPAC**ing	**LIN**ear **LOG**arithmic	**2.10.1** **DISP-Panel** Spacing → LIN → LOG
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**AUTO**	**ON** **OFF**	**2.10.1** **DISP-Panel** Scale → AUTO → MANUAL or Softkey F7 (AUTOSCALE) → F9 (X)
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**LEFT** **DISP**lay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**RIGHT**	**<nu>**	**2.10.1** **DISP-Panel** **Left** Right
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**RLEV**el	**<nu>**	**2.10.1** **DISP-Panel** Reference → VAQLUE

Command	Parameter	Section
DISPlay[:WINDow]:**TRAC**e[]:**X**[:SCALe]:**UNIT**	**V** **Hz** **s** and so on see **3.10.4 Units** for IEC Measurement Results	**2.10.1** **DISP-Panel** Unit
DISPlay[:WINDow]:**TRAC**e[]:**Y**:**AUTO**	**ONCE** **OFF**	**2.10.2** **DISP-Panel** Scale → AUTO ONCE → MANUAL ONCE via Softkey F7 (AUTOSCALE) → F7 (A) → F8 (B)
DISPlay[:WINDow]:**TRAC**e[]:**Y**[:SCALe]:**RLEV**el	**<nu>**	**2.10.1** **DISP-Panel** Reference → VALUE
DISPlay[:WINDow]:**TRAC**e[]:**Y**[:SCALe]:**UNIT**	**<u>** see **3.10.4 Units** for IEC Measurement Results	**2.10.1** **DISP-Panel** Unit
DISPlay[:WINDow]:**TRAC**e[]:**ZOOM**	**<n>** **0** **1** **-1** **2** **3** **4**	**2.10.2** **Softkey** F10 (ZOOM) → F10 (UNZOOM) → F6 (AT o UP) → F7 (AT o DOWN) → F8 (CEN TO o) → F9 (o TO *) → F11 (UNDO)
DISPlay[:WINDow]:**TRAC**e[1]:**Y**:**LAB**el	**'string'**	**2.10.2** **DISP-Panel** Unit/Label
DISPlay[:WINDow]:**TRAC**e[1|2]:**CURV**e	**OFF** **ON**	**2.10.2** **Softkey** → F6 (CURVE) → F6 (A ON/OFF) → F7 (B ON/OFF)

Command	Parameter	Section
DISPlay[:WINDow]:**TRAC**e[1|2]:**FEED**	**'SENSe1:DATA1'** **'SENSe1:DATA2'** **'SENSe2:DATA1'** **'SENSe2:DATA2'** **'SENSe3:DATA1'** **'SENSe3:DATA2'** **'HOLD'** **'FILE'** **'DFILe'** **'OFF'**	**2.10.1** **DISP-Panel** TRACE A/B → FUNC CH1 → FUNC CH2 → INP RMS CH1 → INP RMS CH2 → FREQ CH1 → FREQ CH2 → PHASE → GROUP DEL → HOLD → FILE → DUAL FILE → OFF
DISPlay[:WINDow]:**TRAC**e[1|2]:**MARK**er:**HARM**onics	**ON** **OFF**	**2.10.2** **Softkey** F11 (MARKER) F6 (TRACE A) or F7 (TRACE B) selects → F10 (HARM) on/off
DISPlay[:WINDow]:**TRAC**e[1|2]:**MARK**er:**MODE**	**MAX**imum **CURS**or **OFF**	**2.10.2** **Softkey** F11 (MARKER) F6 (TRACE A) or F7 (TRACE B) selects → MAX → CURSOR → VIEW OFF
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**:**SPAC**ing	**LIN**ear **LOG**arithmic	**2.10.1** **DISP-Panel** Spacing → LIN → LOG
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**[:SCALe]:**AUTO**	**ONCE** **OFF**	**2.10.1** **DISP-Panel** Scale → AUTO ONCE → MANUAL
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**[:SCALe]:**BOTT**om	**<nu>**	**2.10.1** **DISP-Panel** Bottom
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**[:SCALe]:**NORM**alize	**<nu>** 10^{-12} to 10^{6} or -200 dB to 120 dB	**2.10.1** **DISP-Panel** Normalize

Command	Parameter	Section
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**[:SCALe]:**NORM**alize:**MODE**	**CURS**or[1] (o-Cursor) **CURS**or2 (*-Cursor) **VAL**ue	**2.10.1** **DISP-Panel** Normalize → o-Cursor → *-Cursor → VALue
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**[:SCALe]:**RLEV**el:**MODE**	**VAL**ue **MAX**imum **CURS**or[1] **CURS**or 2 **FILE** **HOLD** **OTRA**ce **CH1M**eas **CH2M**eas **GENT**rack **IFIL**e	**2.10.1** **DISP-Panel** Reference → VALUE → MAX → oCURSOR → *CURSOR → FILE → HOLD → OTHER TRACE → MEAS CH1 → MEAS CH2 → GEN TRACK → FILE INTERN
DISPlay[:WINDow]:**TRAC**e[1|2]:**Y**[:SCALe]:**TOP**	**<nu>**	**2.10.1** **DISP-Panel** Top
DISPlay[:WINDow]:**TRAC**e**2**:**Y**:**LAB**el	**'string'**	**2.10.2** **DISP-Panel** Unit/Label
DISPlay[:WINDow]:**TRAC**e**2**:**Y**[:SCALe]:**EQU**al	**ON** **OFF**	**2.10.1** **DISP-Panel** Scale B → EQUAL A → NOT EQUAL A
FORMat[:DATA]	**ASCI**i **REAL**	**2.9.1.2** **No manual control**
HCOPy:**ABOR**t		**2.14** **Taste** H COPY or CTRL F8

Command	Parameter	Section
HCOPy:DESTination	PRSPc alias PRINter PLHPgl alias PLOTter PRPS PRHPgl FIPCx, 'filename.PCX' alias PCXFile, 'name.PCX' FIHPgl, 'filename.GL' alias HPGLfile, 'name.GL' FIPS, 'filename.PS' FIEPs, 'filename.EPS' Query response: PRIN PLOT PRHP PRPS PCXF HPGL FIPS FIEP	**2.14** **OPTIONS-Panel** Destin (**Ziel/Format**) → PRINTR/SPC → PLOTTR/HPGL → PRINTR/HPGL → PRINTR/PS → FILE/PCX → FILE/HPGL → FILE/PS → FILE/EPS
HCOPy:DEVice:**COL**or	**ON** **OFF**	**2.14** **OPTIONS-Panel** COLOR → ON → OFF
HCOPy:DEVice:**PRIN**ter	<n>	**2.14** **OPTIONS-Panel** Printname
HCOPy:DEVice:**RES**olution	**HIGH** **MED**ium **LOW**	**2.14** **OPTIONS-Panel** Prn Resol → HIGH → MEDIUM → LOW
HCOPy:ITEM	**ALL** **GRA**Ticule **TRAC**e	**2.14** **OPTIONS-Panel** Copy → SCREEN → CURVE/GRID → CURVE
HCOPy:ITEM:FRAMe	**WHITe** **FDEF**ined	**2.14** **OPTIONS-Panel** Frame → WHITE → FILE DEF

Command	Parameter	Section
HCOPy:ITEM:LABel:STATe	**ON** **OFF**	**2.14** **Taste** H COPY or Ctrl F8
HCOPy:PAGE:LENGth?	<n> Query only	**2.14** **OPTIONS-Panel** Prn Height
HCOPy:PAGE:LMARgin	<n> 0...80	**2.14** **OPTIONS-Panel** LEFT MRGN
HCOPy:PAGE:ORIentation	**LAND**scape **PORT**trait	**2.14** **OPTIONS-Panel** ORIENTATION → LANDSCAPE → PORTRAIT
HCOPy:PAGE:SCALe:X	<n> 0.1 ...10	**2.14** **OPTIONS-Panel** X-SCALING
HCOPy:PAGE:SCALe:Y	<n> 0.1 ...10	**2.14** **OPTIONS-Panel** Y-SCALING
HCOPy:PAGE:WIDTh?	<n> Query only	**2.14** **OPTIONS-Panel** Prn Width,
HCOPy:PLADdress	<n> 0 to 31	**2.14** **OPTIONS-Panel** → IEC Adr
HCOPy:PLOTs	<n> 1 to 6	**2.14** **OPTIONS-Panel** Plots/Page
HCOPy:PLPort	**COM2** **LPT1** **IEC**	**2.14** **OPTIONS-Panel** Plot on → COM 2 → LPT 1 → IEC BUS
HCOPy:SIZE	**A4** **LETT**er	**2.14** **OPTIONS-Panel** Paper Size → A4 → LETTER
HCOPy:WAIT		**2.14** **No manual control**
HCOPy[:IMMediate]	**CNF** **CF** **NCNF** **NCF** **CONF**ig	**2.14** **Taste** H COPY or CTRL F8

Command	Parameter	Section
INITiate:**CONT**inuous	**ON** **OFF**	**2.11** **Taste START** **Taste SINGLE**
INITiate:***FORC****e***	***STAR****t* ***SING****le* ***STOP*** ***CONT****inuous*	**2.11** → **Taste START** → **Taste SINGLE** → STOP function of toggel key **STOP/CONT** → CONT function of toggel key **STOP/CONT**
INITiate:**NEXT**	**<n>**	**2.11** **Drehrad**
INITiate[:IMMediate]		**2.11** **Taste START** **Taste SINGEL**
INPut:**FIL**Ter[:LPASs]:**FREQ**uency	**<n>** Query only **10** Hz I **20** Hz	**2.6.1** **ANLR-Panel** Min Freq
INPut[]:**AUD**iobits	**<n>** Value range see 2.6.3 Configuration of the Digital Analyzer	**2.6.3** **ANLR-Panel** Audio Bits
INPut[]:**SAMP**le:**FREQ**uency	**<nu>** 100 Hz to 52.5 kHz	**2.6.3** **ANLR-Panel** Sample Frq → VALUE:
INPut[]:**SAMP**le:**FREQ**uency:**MODE**	**F32** **F44** **F48** **VAL**ue **AUTO** **CHST**atus	**2.6.3** **ANLR-Panel** Sample Frq → 32 kHz → 44.1 kHz → 48 kHz → VALUE: → AUTO → CHAN STATUS
INPut[]:**SEL**ect	**CH1** **CH2** **CH1**And2 **CH1**Is2 **CH2**Is1 **BOTH**	**2.6.2** **2.6.3** **ANLR-Panel** CHANNEL(s) → 1 → 2 → 1 & 2 → 1 ≡ 2 → 2 ≡ 1 → BOTH

Command	Parameter	Section
INPut[1|**2**]:**COUP**ling	**AC** **DC**	**2.6.2** **ANLR-Panel** CH1 Coupl CH2 Coupl → AC → DC
INPut[1|**2**]:**IMP**edance	**R300** **R600** **R200K**	**2.6.2** **ANLR-Panel** Imped → 300 Ω → 600 Ω → 200 kΩ
INPut[1|**2**]:**LOW**	**FLO**at **GRO**und	**2.6.2** **ANLR-Panel** Common → FLOAT → GROUND
INPut[1|**2**]:**TYPE**	**BAL**anced **GEN1** **GEN2** **AES**ebu **SPD**if **OPT**ical **INT**ern	**2.6.2** **2.6.3** **ANLR-Panel** Input → BAL XLR → GEN1 → GEN2 → GEN CROSSED → BAL (XLR) → UNBAL (XLR) → OPTICAL → INTERN
INSTrument[1]:**NSEL**ect	**1** **3**	**2.5.1** **GEN-Panel** INSTRUMENT → ANALOG → DIGITAL
INSTrument[1][:SELect]	**A25** **D48**	**2.5.1** **GEN-Panel** INSTRUMENT → ANALOG → DIGITAL
INSTrument**2**:**NSEL**ect	**1** **2** **4**	**2.6.1** **ANLR-Panel** INSTRUMENT → ANLG 22 kHz → ANLG 110 kHz → DIGITAL
INSTrument**2**[:SELect]	**A22** **A110** **D48**	**2.6.1** **ANLR-Panel** INSTRUMENT → ANLG 22 kHz → ANLG 110 kHz → DIGITAL

Command	Parameter	Section
MMEMory:**CDIR**ectory	**'pathname'**	**2.9.2** **FILE-Panel** Work Dir
MMEMory:**COPY**	**'filename1','filename2'**	**2.9.2** **FILE-Panel** Copy + To
MMEMory:**DEL**ete	**'filename'**	**2.9.2** **FILE-Panel** Delete
MMEMory:**LOAD**:**LIST**	**LIMU**pper, **'filename'** Query-Form MMEM:LOAD:LIST? LIMU	**2.10.7** **DISP-Panel** Lim Upper → FILE + filename
MMEMory:**LOAD**:**LIST**	**LIML**ower, **'filename'** Query-Form MMEM:LOAD:LIST? LIML	**2.10.7** **DISP-Panel** Lim Lower → FILE + filename
MMEMory:**LOAD**:**LIST**	**EQU**alize,**'filename'** Query: MMEM:LOAD:LIST? EQU	**2.5.4.3** and **2.5.4.4** **GEN-Panel** Equal File → FILE + filename
MMEMory:**LOAD**:**LIST**	**ARB**itrary,**'filename'** Query: MMEM:LOAD:LIST? ARB **RAND**om,**'filename'** Query: MMEM:LOAD:LIST? RAND	**2.5.4.9** and **2.5.4.10** **GEN-Panel** Shape File → FILE + filename
MMEMory:**LOAD**:**LIST**	**DWEL**l,**'filename'** Query: MMEM:LOAD:LIST? DWEL	**2.5.4.2** **GEN-Panel** Dwell File → FILE + filename
MMEMory:**LOAD**:**LIST**	**FREQ**uency[1|2],**'filename'** Query-Form MMEM:LOAD:LIST? FREQ[1|2]	**2.5.4.2** **GEN-Panel** FREQ FILE → FILE + filename
MMEMory:**LOAD**:**LIST**	**FREQ**uency,**'filename'** Query-Form MMEM:LOAD:LIST? FREQ	**2.6.5.3** **2.9.1.3** **ANLR-Panel** SWEEP CTRL → FILE + filename
MMEMory:**LOAD**:**LIST**	**INT**erval,**'filename'** Query: MMEM:LOAD:LIST? INT	**2.5.4.5** **2.5.4.6** **GEN-Panel** INTV FILE → FILE + filename

Command	Parameter	Section
MMEMory:**LOAD**:**LIST**	**ONT**ime,**'filename'** Query: MMEM:LOAD:LIST? ONT	**2.5.4.5** **2.5.4.6** **GEN-Panel** ONTIM FILE → FILE + filename
MMEMory:**LOAD**:**LIST**	**VOLT**age[1|2],**'filename'** Query: MMEM:LOAD:LIST? VOLT[1|2]	**2.5.4.2** **GEN-Panel** VOLT FILE → FILE + filename
MMEMory:**LOAD**:**LIST**	**DWEL**l2,**'filename'** Query: MMEM:LOAD:LIST? DWEL2	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN: Dwell File → FILE + filename
MMEMory:**LOAD**:**LIST**	**FREQ**uency2,**'filename'** Query-Form MMEM:LOAD:LIST? FREQ2	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN FREQUENCY FREQ FILE → FILE + filename
MMEMory:**LOAD**:**LIST**	**VOLT**age2,**'filename'** Query: MMEM:LOAD:LIST? VOLT2	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN VOLTAGE I AMPL VOLT FILE → FILE + filename
MMEMory:**LOAD**:**LIST**	**EQU**alizer,**'filename'.** Query: MMEM:LOAD:LIST? EQU	**2.5.4.4** **GEN-Panel** Equal.File → FILE + filename
MMEMory:**LOAD**:**LPGC,**	**'filename'**	**2.5.3.2** **GEN-Panel** Filename
MMEMory:**LOAD**:**PAC,**	**'filename'**	**2.10.8** **DISP-Panel** Proto File
MMEMory:**LOAD**:**PAU,**	**'filename'**	**2.10.8** **DISP-Panel** Proto File
MMEMory:**LOAD**:**PGU,**	**'filename'**	**2.5.3.2** **GEN-Panel** Filname
MMEMory:**LOAD**:**RPGC,**	**'filename'**	**2.5.3.2** **GEN-Panel** Filename

Command	Parameter	Section
MMEMory:**LOAD**:**STAT**e	**0|1|2, 'filename'** Query: MMEM:LOAD:STAT? 0 MMEM:LOAD:STAT? 1 MMEM:LOAD:STAT? 2	**2.9.1.1** **FILE-Panel** Mode / Filename
MMEMory:**LOAD**:**TRAC**e	**TRAC**e[1|2],**'filename'** Query: MMEM:LOAD:TRAC? TRAC[1|2]	**2.10.1** **DISP-Panel** TRACE A/B → FILE + Filename
MMEMory:**LOAD**:**TRAC**e[1|2]	**REFT**race,**'filename'** Query: MMEM:LOAD:TRAC[1|2]? REFT	**2.10.1** **DISP-Panel** Reference → FILE + Reference
MMEMory:**STOR**e:**FORM**at	**BIN** **ASC**ii	**2.9.1.2** **FILE-Panel** Format → REAL → ASCII
MMEMory:**STOR**e:**INFO**text	**'string'**	**2.9.1.1** FILE-Panel Info Text
MMEMory:**STOR**e:**LIST**	**LIST**[1|2], **'filename'** **DWEL**[1|2], **'filename'** **ERR**ors, **'filename'** **LIMU**pper, **'filename'** **LIML**ower, **'filename'** **EQU**alize, **'filename'** Query: MMEM:STOR:LIST? LIST[1|2] MMEM:STOR:LIST? DWEL[1|2] MMEM:STOR:LIST? LIMU MMEM:STOR:LIST? LIML MMEM:STOR:LIST? EQU	**2.9.1.2** **FILE-Panel** Store → X-Axis → Z-Axis → DWEL VALUE → LIM REPORT → LIM UPPER → LIM LOWER → EQUALIZATN
MMEMory:**STOR**e:**STAT**e	**0|2,'filename'** Query: MMEM:STOR:STAT? 0 MMEM:STOR.STAT? 2	**2.9.1.1** **FILE-Panel** Mode / Filename
MMEMory:**STOR**e:**STAT**e:**RONL**y	**ON** **OFF**	**2.9.1.1** **FILE-Panel** Attrib → READ ONLY → READ/WRITE
MMEMory:**STOR**e:**TRAC**e	**TRAC**e[1|2],**'filename'** **TR1A**nd2,**'filename'** Query: MMEM:STOR:TRAC? TRAC[1|2] MMEM:STOR:TRAC? TR1A	**2.9.1.2** **FILE-Panel** Store → TRACE A → TRACE B → TRACE A+B

Command	Parameter	Section
OUTPut	**ON** **OFF**	**2.13** Taste OUTPUT OFF
OUTPut:AUDiobits	<n> = 8 to 24	**2.5.3** **GEN-Panel** Audio Bits
OUTPut:DIGital:**CSIM**ulator	**OFF** **SIML**ong	**2.5.3** **GEN-Panel** Cable Sim → OFF → LONG CABLE
OUTPut:DIGital:**REF**erence:**FEED**	**AINP**ut **AINR**eclock **AOUT**put **RGEN**erator	**2.5.3** **GEN-Panel** Ref Out → AUDIO IN → AUD IN RCLK → AUDIO OUT → REF GEN
OUTPut:DIGital:**SYNC**:**FEED**	**AI**Put **GCL**ock **RINP**ut **SPLL**	**2.5.3** **GEN-Panel** Sync Out → AUDIO IN → GEN CLK → REF IN → SYNC PLL
OUTPut:DIGital:**SYNC**:**TYPE**	**WCL**ock **BCL**ock	**2.5.3** **GEN-Panel** Type → WORD CLK → BIPHASE CLK
OUTPut:DIGital:**UNB**alanced:**FEED**	**AOUT**put **AINP**ut	**2.5.3** **GEN-Panel** Unbal Out → AUDIO OUT → AUDIO IN
OUTPut:IMPedance	**R10** **R200** **R150** (Query response = R200) **R600**	**2.5.2** **GEN-Panel** Impedance → 10 Ω → 200 Ω → 150 Ω → 600 Ω
OUTPut:SAMPle:**FREQ**uency	<nu> 30 kHz to 52.5 kHz	**2.5.3** **GEN-Panel**

Command	Parameter	Section
OUTPut:**SAMP**le[:FREQuency]:**MODE**	**F32** **F44** **F48** **EXT**ern **SYNC**hron **VAL**ue	**2.5.3** **GEN-Panel** Sample Freq → 32 kHz → 44.1 kHz → 48 kHz → EXTERN → SYNCHRON → VALUE:
OUTPut:**SEL**ect	**OFF** **CH1** **CH2** **CH2**ls1	**2.5.2** and **2.5.3** **GEN-Panel** Channel(s) → OFF → 1 → 2 → 2 ≡ 1
OUTPut:**SIGN**al:**BAL**anced:**LEV**el	**<nu>**	**2.5.3** **GEN-Panel** Bal Vpp
OUTPut:**SIGN**al:**LEV**el	**<nu>**	**2.5.3** **GEN-Panel** Unbal Vpp
OUTPut:**TYPE**	**BAL**anced **UNB**alanced	**2.5.2** **GEN-Panel** Output → BAL → UNBAL
OUTPut:**VAL**idity	**CH1**And2 **NONE**	**2.5.3.2** **GEN-Panel** Validity
OUTPut2:**IMP**edance	**R10** **R200** **R600**	**2.5.5** **GEN-Panel** AUX GEN: Impedance → 10 Ω → 200 Ω → 600 Ω
OUTPut2:**SEL**ect	**OFF** **CH1** **CH2** **CH2**ls1	**2.5.5** **GEN-Panel** AUX GEN: Channel(s) → OFF → 1 → 2 → 2 ≡ 1
OUTPut2:**TYPE**	**UNB**alanced **BAL**anced	**2.5.5** **GEN-Panel** AUX GEN: Output → UNBAL → BAL

Command	Parameter	Section
SENSe:DIGital:FEED	ADATa JPHase CINPut	2.6.3.1 ANLR-Panel Meas Mode → AUDIO DATA → JITTER/PHAS → COMMON/INP
SENSe:DIGital:SYNC:REFerence	GCLock PLLVari PLL32 PLL44 PLL48	2.6.3 ANLR-Panel Related to → GEN CLK → VARI (PLL) → 32.0 (PLL) → 44.1 (PLL) → 48.0 (PLL)
SENSe:DIGital:SYNC:SOURce	AINPut RINPut	2.6.3 ANLR-Panel Sync To → AUDIO IN → REF IN
SENSe:FREQuency:FACTor	<nu> MLT 1...20 for RMS-Sel. measurement	2.6.5.3 2.6.5.23 ANLR-Panel FREQ MODE → Factor
SENSe[1]:FUNCtion	'OFF' 'RMS' 'RMSSelectiv' 'PEAK' 'QREak' 'DC' 'THD' 'THDNsndr' 'MDISt' 'DFD' 'WAF' 'POLarity' 'FFT' 'FILTersimulation' 'WAVeform' 'PROTocol' 'PHASetoref' 'DIG Inpamp' 'THIRdoct'	2.6.5 ANLR-Panel FUNCTION
SENSe:SWEep:SYNC	NORMal BLOCk	2.6.5.1 2.6.5.23 ANLR-Panel Sweep Mode → NORMAL → BLOCK
SENSe:UFILter[1...9]:ORDer	N4 N8	2.7.2 FILTER-Panel Order → 4 → 8

Command	Parameter	Section
SENSe:VOLTage:INTV:MODE	**OFF** **FOR**ever **SMO**oth **EDGE**	**2.6.5.24** **ANLR-Panel** Max Hold → OFF → FOREVER → SLOW DECAY → FAST DECAY
SENSe[]:POWer:REFerence:RESistance	<nu> 1 mΩ to 100 kΩ	**2.4** (RREF) **2.6.2** **ANLR-Panel** Ref Imped
SENSe[]:VOLTage:RANGe[1|2]:AUTO	**ON** **OFF**	**2.6.22.6.2** **ANLR-Panel** Range → AUTO
SENSe[]:VOLTage:RANGe[1|2]:LOWer	<nu> Value range see 2.6.2 Configuration of the Analog Analyzers	**2.6.2** **ANLR-Panel** Range → LOWER
SENSe[]:VOLTage:RANGe[1|2][:UPPer]	<nu> Value range see 2.6.2 Configuration of the Analog Analyzers	**2.6.2** **ANLR-Panel** Range → FIX
SENSe[1]:BWIDth[:RESolution] gleichbedeutend mit SENSe[1]:BANDwidth[:RESolution]	<nu> Value range determined by instrument or function	**2.6.5.3** **ANLR-Panel** Bandwidth
SENSe[1]:BWIDth[:RESolution]:MODE gleichbedeutend mit SENSe[1]:BANDwidth[:RESolution]:MODE	**PPCT1** **PPCT3** **PTOC**t **POCT12** **PFIX** **PFAS**t **SPCT1** **SPCT3** **STOC**t **SOCT12** **SFIX** **SFAS**t	**2.6.5.3** **ANLR-Panel** Bandwidth → BP 1% → BP 3 % → BP 1/3 OCT → BP 1/12 OCT → BP FIX: → BP FAST → BS 1% → BS 3 % → BS 1/3 OCT → BS 1/12 OCT → BS FIX: → BS FAST
SENSe[1]:CHANnel:DELay	<nu> -10 to 10 s	**2.6.5.12** **2.6.5.22** **ANLR-Panel** Chan Delay
SENSe[1]:DATA1|2?	<n> Query only	**3.15.8** **Result display**

Command	Parameter	Section
SENSe[1]:**FILT**er<i>	<i>*) = 1 to 3 **OFF** Query returns name of the filter switched on: **UFIL1** : **UFIL9** **AWE** **CMES** **CCIT** **CCIR** **CCIU** **DEMP5015** **DEMP50** **DEMP75** **DEMP17** **WRUM** **URUM** **DCN** **CARM** **IECT** **JITT**	**2.7.1** **FILTER-Panel** Filter
SENSe[1]:**FILT**er<i>:**AWE**ighting[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → A Weighting
SENSe[1]:**FILT**er<i>:**CARM**[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → CCIR ARM
SENSe[1]:**FILT**er<i>:**CCIR**[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → CCIR wtd
SENSe[1]:**FILT**er<i>:**CCIT**t[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → CCITT
SENSe[1]:**FILT**er<i>:**CCIU**nweight[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → CCIR unwtd
SENSe[1]:**FILT**er<i>:**CMES**sage[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → C MESSAGE
SENSe[1]:**FILT**er<i>:**DCN**oise[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → DC NOISE HP

Command	Parameter	Section
SENSe[1]:**FILT**er<i>:**DEMP**hasis**17**[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → DEEMPH J.17
SENSe[1]:**FILT**er<i>:**DEMP**hasis**50**[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → DEEMPH 50
SENSe[1]:**FILT**er<i>:**DEMP**hasis**5015**[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → DEEM 50/15
SENSe[1]:**FILT**er<i>:**DEMP**hasis**75**[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → DEEMPH 75
SENSe[1]:**FILT**er<i>:**IECTuner**[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → IEC Tuner
SENSe[1]:**FILT**er**<i>**:**JITT**er[:STATe]	<i> 1 to 4 **ON** | **OFF**	**2.7.1** **FILTER-Panel** Filter → JITTER wtd
SENSe[1]:**FILT**er<i>:**UFIL**ter**1...**:**UFIL**ter**9**[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter
SENSe[1]:**FILT**er<i>:**URUM**ble[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → RUMBLE unw
SENSe[1]:**FILT**er<i>:**WRUM**ble[:STATe]	<i> 1 to 3 **ON**|**OFF**	**2.7.1** **FILTER-Panel** Filter → RUMBLE wtd
SENSe[1]:**FREQ**uency:**APER**ture:**MODE**	**FAST** **PREC**ision	**2.6.5.19** **ANLR-Panel** Meas Time → FAST → PRECISION
SENSe[1]:**FREQ**uency:**LIM**it:**LOW**er	**<nu>** Value range determined by instrument or function	**2.6.5.7** **2.6.5.23** **2.6.5.24** **ANLR-Panel** → Frq Lim Low

Command	Parameter	Section
SENSe[1]:**FREQ**uency:**LIMi**t:**UPP**er	**<nu>** Value range determined by instrument or function	**2.6.5.7** **2.6.5.23** **2.6.5.24** **ANLR-Panel** → Frq Lim Upp
SENSe[1]:**FREQ**uency:**MODE**	**FIX**ed|**CW** **SWE**ep **LIST** **MULT**isine **GENT**rack **CH1** **CH2**	**2.6.5.3** **ANLR-Panel** SWEEP CTRL → OFF → AUTO SWEEP MANU SWEEP → AUTO LIST MANU LIST → GEN MLTSINE FREQ MODE → GEN TRACK → FREQ CH1 → FREQ CH2
SENSe[1]:**FREQ**uency:**STAR**t **SENS**e[1]:**FREQ**uency:**STOP**	<nu> Value range determined by instrument or function	**2.6.5.3** **ANLR-Panel** SWEEP CTRL → Start | Stop
SENSe[1]:**FREQ**uency[:FIX**ed**|**CW**]	<nu> Value range determined by instrument or function	**2.6.5.3** **ANLR-Panel** FREQ MODE → FIX
SENSe[1]:**FUNC**tion	**'OFF'** **'RMS'** **'RMSS**electiv' **'PEAK'** **'QPE**ak' **'DC'** **'THD'** **'THDN**sndr' **'MDIS**t' **'DFD'** **'WAF'** **'POL**arity' **'FFT'** **'FILT**ersim' **'WAV**eform' **'PROT**ocol'	**2.6.5** **ANLR-Panel** FUNCTION → OFF → RMS & S/N → RMS SELECT → PEAK & S/N → QPK & S/N → DC → THD → THD+N/SINAD → MOD DIST → DFD → WOW & FL → POLARITY → FFT → FILTER SIM. → WAVEFORM → PROTOCOL
SENSe[1]:**FUNC**tion:**DCS**uppression	**ON** **OFF**	**2.6.5.1** ANLR-Panel DC Suppres → ON → OFF
SENSe[1]:**FUNC**tion:**DIST**ortion	**<n>**	**2.6.5.6** **ANLR-Panel** → di2468

Command	Parameter	Section
SENSe[1]:**FUNC**tion:**DMOD**e	**FAST** **PREC**ision	**2.6.5.6** **2.6.5.7** **2.6.5.8** **2.6.5.9** **ANLR-Panel** Dyn Mode → FAST → PRECISION
SENSe[1]:**FUNC**tion:**MMOD**e	 **PPE**ak **NPE**ak **PTOP**eak **PABS**olut **SEL**ectdi **LSEL**ectdi **DALL** **LDALl** **DODD** **LDOD**d **DEV**en **LDEV**en **THDN** **LTHD**n **SNDR**atio **NOIS**e **LNO**ise **D2_268** alias **D2** **D3_268** alias **D3** **D2_118** **D3_118** **STAN**dard **COMP**ressed **USAM**pl **O33**	**2.6.5.4** **ANLR-Panel** Meas Mode → PK + → PK - → PK to PK → PK abs **2.6.5.6** → SELECT di → LEV SEL di → All di → LEV All di → All odd di → LEV odd di → All even di → LEV even di **2.6.5.7** → THD+N → LEVEL THD+N → SINAD → NOISE → LEVEL NOISE **2.6.5.9** → d2 (IEC268) → d3 (IEC268) → d2 (IEC118) → d3 (IEC118) **2.6.5.14** → STANDARD → COMPRESSED → UNDERSAMP
SENSe[1]:**FUNC**tion:**SETT**ling:...		**2.3.4.2** **ANLR-Panel** Fnct Settl
SENSe[1]:**FUNC**tion:**SETT**ling:**COUN**t	**<n>** EXP | FLAT: 2 to 6 AVER: 2 ...100	**2.6.5.1** **ANLR-Panel** Samples
SENSe[1]:**FUNC**tion:**SETT**ling:**MODE**	**OFF** **EXP**onential **FLAT** **AVER**age	**2.6.5.1** **ANLR-Panel** Settling → OFF → EXPonential → FLAT → AVERage

Command	Parameter	Section
SENSe[1]:**FUNC**tion:**SETTl**ing:**RES**olution	<nu> Value range and units are determined by instrument or function see 2.6.5.1	**2.6.5.1** **ANLR-Panel** Resolution
SENSe[1]:**FUNC**tion:**SETTl**ing:**TOL**erance	<n> 0.001 to 10 %	**2.6.5.1** **ANLR-Panel** Tolerance
SENSe[1]:**FUNC**tion:**SETTl**ing:**TOUT**	<nu> 0.001 ...10 s	**2.6.5.1** **ANLR-Panel** Timeout
SENSe[1]:**FUNC**tion:**SNS**equence	**ON** **OFF**	**2.6.5.1** **ANLR-Panel** S/N Sequ → ON → OFF
SENSe[1]:**FUNC**tion:**STAN**dard	**NAB** **JIS** **DIN**iec **SI05** **SI10**	**2.6.5.10** **ANLR-Panel** Rule → NAB → JIS → DIN/IEC → 2 Sigma 5 s → 2 Sigma 10s
SENSe[1]:**FUNC**tion:**WEIG**hting	**ON** **OFF**	**2.6.5.10** **ANLR-Panel** Weighting → ON → OFF
SENSe[1]:**LIST**:**FREQ**uency	<n>{,<n>}	**2.9.1.3** **No manual control**
SENSe[1]:**LIST**:**FREQ**uency:**POIN**ts?	<n> 0 to 1023 Query only	**2.9.1.3** **No manual control**
SENSe[1]:**LIST**:**MODE**	**AUTO** **MAN**ual	**2.6.5.3** **ANLR-Panel** SWEEP CTRL → AUTO LIST → MANU LIST
SENSe[1]:**NOTC**h:**FREQ**uency:**FIX**ed	<nu> Value range determined by instrument or function	**2.6.5.1** **ANLR-Panel** Notch Freq → VALUE:
SENSe[1]:**NOTC**h:**FREQ**uency:**MODE**	**FIX**ed **GENT**rack	**2.6.5.1** **ANLR-Panel** Notch Freq → VALUE: → GEN TRACK

Command	Parameter	Section
SENSe[1]:**NOTC**h[:STATe]	**DB0** **DB12** **DB30** **OFF**	**2.6.5.1** **ANLR-Panel** Anlg. Notch → 0 dB → 12 dB → 30 dB → OFF
SENSe[1]:**O33?**	Query only Query response: ASCII string.	**No manual control**
SENSe[1]:**SMO**othing:**APER**ture	**N1** **N2** **N4** **N8** **N16** **N32**	**2.6.5.14** **ANLR-Panel** Interpol → 1 → 2 → 4 → 8 → 16 → 32
SENSe[1]:**SWE**ep:**MODE**	**AUTO** **MAN**ual	**2.6.5.3** **ANLR-Panel** SWEEP CTRL → AUTO SWEEP → MANU SWEEP
SENSe[1]:**SWE**ep:**POIN**ts	**<n>** 2 to 1024	**2.6.5.3** **ANLR-Panel** Points
SENSe[1]:**SWE**ep:**SPAC**ing	**LIN**ear **LOG**arithmic	**2.6.5.3** **ANLR-Panel** Spacing → LIN → LOG
SENSe[1]:**SWE**ep:**STEP**	**<nu>** | **<n>**	**2.6.5.3** **ANLR-Panel** Steps
SENSe[1]:**THDN**:**REJ**ection	**NARR**ow **WIDE**	**2.6.5.7** **ANLR-Panel** Rejection → NARROW → WIDE
SENSe[1]:**TRIG**ger:**SETTl**ing:.....		**2.3.4.2** **ANLR-Panel** Fnct Settl
SENSe[1]:**TRIG**ger:**SETTl**ing:**COUN**t	**<n>** EXP | FLAT: 2...6 AVER: 2...100	**2.6.5.1** **ANLR-Panel** Samples

Command	Parameter	Section
SENSe[1]:**TRIG**ger:**SETT**ling:**MODE**	**OFF** **EXP**onential **FLAT** **AVER**age	**2.6.5.1** **ANLR-Panel** Settling → OFF → EXPONENTIAL → FLAT → AVERAGE
SENSe[1]:**TRIG**ger:**SETT**ling:**RES**olution	**<nu>** Value range and units determined by instrument or function see 2.6.5.1	**2.6.5.1** **ANLR-Panel** Resolution
SENSe[1]:**TRIG**ger:**SETT**ling:**TOL**erance	**<n>** 0.001 to 10 %	**2.6.5.1** **ANLR-Panel** Tolerance
SENSe[1]:**UFIL**ter<i>:**ATT**enuation	<i> 1 to 9 **<nu>** 3...120 dB	**2.7.2.1** **FILTER-Panel** FILTER 1 to 9 → Atten
SENSe[1]:**UFIL**ter<i>:**BPAS**s[:STATe]	<i> 1 to 9 **ON**	**2.7.2** **FILTER-Panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**BSTO**p[:STATe]	<i> 1 to 9 **ON**	**2.7.2** **FILTER-Panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**CENT**er	<i> 1 to 9 **<nu>** Value range see 2.6.1 Selecting the Analyzer	**2.7.2.4** and **2.7.2.5** **FILTER-Panel** FILTER 1 to 9 → Center Frq
SENSe[1]:**UFIL**ter<i>:**DEL**ay	<i> 1 to 9 **<nu>** 0 to 1 s Query only for all filters except for file-defined filters	**2.7.2.7** **2.7.2.1** Query only **FILTER-Panel** FILTER 1 to 9 → Delay
SENSe[1]:**UFIL**ter<i>:**FILE**	**'filename'** <i> 1 to 9	**2.7.2.7** **FILTER-Panel** FILTER 1 to 9 → Filename
SENSe[1]:**UFIL**ter<i>:**FILE**[:STATe]	<i> 1 to 9 **ON**	**2.7.2** **FILTER-Panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**HPAS**s[:STATe]	<i> 1 to 9 **ON**	**2.7.2** **FILTER-Panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**LPAS**s[:STATe]	<i> 1 to 9 **ON**	**2.7.2** **FILTER-Panel** FILTER 01 to 09

Command	Parameter	Section
SENSe[1]:**UFIL**ter<i>:**NOTC**h[:STATe]	<i> 1 to 9 **ON**	**2.7.2** **FILTER-Panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**OCT**av[:STATe]	<i> 1 to 9 **ON**	**2.7.2** **FILTER-Panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**PASS**b	<i> 1 to 9 <**nu**> Value range see **2.6.1**	**2.7.2.2** **FILTER-Panel** FILTER 1 to 9 → Passband
SENSe[1]:**UFIL**ter<i>:**PASS**b:**LOW**er	<i> 1 to 9 <**nu**> Value range see **2.6.1**	**2.7.2.3** **FILTER-Panel** FILTER 1 to 9 → Passb low
SENSe[1]:**UFIL**ter<i>:**PASS**b:**UPP**er	<i> 1 to 9 <**nu**> Value range see **2.6.1**	**2.7.2.3** **FILTER-Panel** FILTER 1 to 9 → Passb upp
SENSe[1]:**UFIL**ter<i>:**STOP**b:**LOW**er?	<i> 1 to 9 <**nu**> Query only	**2.7.2.3** **FILTER-Panel** FILTER 1 to 9 → Stopb low
SENSe[1]:**UFIL**ter<i>:**STOP**b:**UPP**er?	<i> 1 to 9 <**nu**> Query only	**2.7.2.3** **FILTER-Panel** FILTER 1 to 9 → Stopb upp
SENSe[1]:**UFIL**ter<i>:**STOP**b?	<i> 1 to 9 <**nu**> Query only	**2.7.2.2** **FILTER-Panel** FILTER 1 to 9 → Stopband
SENSe[1]:**UFIL**ter<i>:**TOCT**ave[:STATe]	<i> 1 to 9 **ON**	**2.7.2** **FILTER-Panel** FILTER 01 to 09
SENSe[1]:**UFIL**ter<i>:**WIDT**h	<i> 1 to 9 <**nu**> Value range see **2.6.1**	**2.7.2.4** and **2.7.2.5** **FILTER-Panel** FILTER 1 to 9 → Width
SENSe[1]:**UNIT**	**PCT**|**DB**	**2.4** **ANLR-Panel** Unit
SENSe[1]:**VOLT**age:**APER**ture	<**nu**> = >1 ms ... Value range see **2.6.5.2**	**2.6.5.2** **2.6.5.3** **2.6.5.24** **ANLR-Panel** Meas Time

Command	Parameter	Section
SENSe[1]:**VOLT**age:**APER**ture:**MODE**	**AFAS**t **AUTO** **TRIG**gered **VAL**ue **FAST**	**2.6.5.2,** **2.6.5.3** **2.6.5.5** **2.6.5.24** **ANLR-Panel** Meas Time → AUTO FAST → AUTO → TRIGGERED → VALUE → FIX 200ms
SENSe[1]:**VOLT**age:**FUND**amental	**<nu>** Value range and units determined by instrument or function	**2.6.5.6** **ANLR-Panel** Fundamentl
SENSe[1]:**VOLT**age:**FUND**amental:**MODE**	**AUTO** **VAL**ue	**2.6.5.6** and **2.6.5.7** **ANLR-Panel** Fundamentl → AUTO → VALUE:
SENSe[1]:**VOLT**age:**INTV**time	**<nu>** 20 ms to 10 s 20 ms to 100 s	**2.6.5.4** **2.6.5.24** **ANLR-Panel** Intv Time
SENSe[1]:**VOLT**age:**INTV**time:**MODE**	**SFAS**t **FAST** **SLOW** **FIX**ed **VAL**ue	**2.6.5.4** **ANLR-Panel** Intv Time → FIX 50ms → FIX 200ms → FIX 1000ms → FIX 3 SEC → VALUE:
SENSe[1]:**WAV**eform:**COMP**ression	**<n>** 2...1024	**2.6.5.14** **ANLR-Panel** Comp Fact
SENSe[1]:**WAV**eform:**DUR**ation	**<nu>** see 2.6.5.14 WAVEFORM	**2.6.5.14** **ANLR-Panel** Trace Len
SENSe[1][:VOLTage|POWer]:**UNIT**[1|**2**]	**PCT** **DB** see 3.10.4 Units for IEC Measurement Results	**2.4** **ANLR-Panel** Unit Ch1/Ch2
SENSe[1][:VOLTage|POWer]:**REF**erence	**<nu>** Analog instruments 100 pV...1000 V Digital instrument 0.0 to 1.0 FS	**2.6.5.1** **ANLR-Panel** Reference
SENSe[1][:VOLTage|POWer]:**REF**erence	**<nu>** Analog instruments: 100 pV to 1000 V Digital instrument: 100 pFS to 100 FS	**2.6.5.1** **ANLR-Panel** Ref Volt

Command	Parameter	Section
SENSe[1][:VOLTage|POWer]:**REF**erence:**MODE**	**CH1**Store **CH2**Store **CH1**Meas **CH2**Meas **STOR**e **GEN**Track **VAL**ue	**2.6.5.1** **ANLR-Panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:
SENSe[1][:VOLTage|POWer]:**REF**erence:**MODE**	***CH1**Store* ***CH2**Store* ***CH1**Meas* ***CH2**Meas* ***VAL**ue*	**2.6.5.1** **ANLR-Panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → VALUE:
SENSe[1|2][:VOLTage|POWer]:**UNIT**[1|2]	**V** | **DBV** | **DBU** | **FS** | **DBM** | **W** | **DPCTV** | **DV** | **VVR** | **PCTVVR** | **DPCTW** |**DW** | **PPR** | **PCTPPR** | **PCTFS** | **DBFS** | **DPCT** |**DBR**	**2.4** **ANLR-Panel** Unit Ch1/Ch2
SENSe2:**DATA**1|2?	**<nu>** Query only	**3.15.8** **Result display**
SENSe2:**FUNC**tion	**'OFF'** **'PEAK**voltage' **'RMS'** **'PHAS**etoref' **'DIG**Inpampl'	**2.6.5.18** **ANLR-Panel** INPUT DISP → OFF → PEAK → RMS → PHAS to REF → DIG INP AMP
SENSe2:**VOLT**age:**REF**erence	**<nu>** Analog instruments 1 mV to 1000 V Digital instrument 0.0 to 1.0 FS	**2.6.5.1** **ANLR-Panel** Reference
SENSe2:**VOLT**age:**REF**erence:**MODE**	**CH1**Store **CH2**Store **STOR**e **CH1**Meas **CH2**Meas **GEN**Track **DIG**outampl **VAL**ue	**2.6.5.1** **ANLR-Panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → DIG OUT AMP → VALUE:
SENSe3:**DATA**1|2?	Query only	**3.15.8** **Result display**
SENSe3:**FREQ**uency:**REF**erence	**<nu>** -1 MHz to 1 MHz	**2.6.5.1** **ANLR-Panel** Ref Freq

Command	Parameter	Section
SENSe3:FREQuency:REFerence:MODE	**CH1**Store **CH2**Store **CH1**Meas **CH2**Meas **STOR**e **GEN**Track **VAL**ue	**2.6.5.1** **ANLR-Panel** Reference → STORE CH1 → STORE CH2 → MEAS CH1 → MEAS CH2 → STORE → GEN TRACK → VALUE:
SENSe3:FREQuency:REFerence:*MODE*	*CH1Store* *CH2Store* *STORe* *CH1Meas* *CH2Meas* *GENTrack* *VALue*	2.6.5.19 **ANLR-Panel** Ref Freq → STORE CH1 → STORE Ch2 → STORE → MEAS CH1 → MEAS CH2 → GEN TRACK → VALUE:
SENSe3:FREQuency:SETTling:.....		**2.3.4.2** **ANLR-Panel** Freq Settl
SENSe3:FREQuency:SETTling:COUNt	<n> EXP | FLAT: 2...6 AVER: 2...100	**2.6.5.1** **ANLR-Panel** Samples
SENSe3:FREQuency:SETTling:MODE	**OFF** **EXP**onential **FLAT** **AVER**age	**2.6.5.1** **ANLR-Panel** Settling → OFF → EXPonential → FLAT → AVERage
SENSe3:FREQuency:SETTling:RESolution	<nu> Value range and units determined by instrument or function see **2.6.5.1**	**2.6.5.1** **ANLR-Panel** Resolution
SENSe3:FREQuency:SETTling:TOLerance	<nu> 0.001 to 10 %	**2.6.5.1** **ANLR-Panel** Tolerance
SENSe3:FREQuency:SETTling:TOUT	<nu> 0.001...10 s	**2.6.5.1** **ANLR-Panel** Timeout
SENSe3:FREQuency:UNIT[1|2]	**HZ** **DHZ** **DPCTHZ** **TERZ** **OCT** **DEC** **FFR**	**2.4** **ANLR-Panel** Unit Ch1/Ch2

Command	Parameter	Section
SENSe3:FUNCtion	**'OFF'** **'FREQ**uency' **'SFRE**quency' **'FQPH**ase' **'FQGR**oupdelay'	**2.6.5.19** 2.6.5.20 2.6.5.21 **ANLR-Panel** FREQ/PHAS → OFF → FREQ → SAMPLE FREQ → FREQ&PHASE → FREQ&GRPDEL
SENSe3:PHASe:FORMat	**POS**itive **POSN**egative **NEG**ative **RAD** **RADB**ipolar **RADN**egative	**2.6.5.19** **ANLR-Panel** Format Pha → 0 to 360° → -180° to 180° → - 360° to 0° → 0 to 2 π → - π to + π → -2 π το 0
SENSe3:PHASe:REFerence	**<nu>** -360°...+360°	**2.6.5.1** **ANLR-Panel** Reference
SENSe3:PHASe:REFerence:**MODE**	**STOR**e **VAL**ue	**2.6.5.1** **ANLR-Panel** Reference → STORE → VALUE:
SENSe3:PHASe:SETTLing:.....		**2.3.4.2** **ANLR-Panel** Phas Settl
SENSe3:PHASe:SETTLing:**COUN**t	**<n>** EXP ! FLAT: 2...6 AVER: 2...100	**2.6.5.1** **ANLR-Panel** Samples
SENSe3:PHASe:SETTLing:**MODE**	**OFF** **EXP**onential **FLAT** **AVER**age	**2.6.5.1** **ANLR-Panel** Settling → OFF → EXPonential → FLAT → AVERage
SENSe3:PHASe:SETTLing:**RES**olution	**<nu>** Value range and units determined by instrument or function see **2.6.5.1**	**2.6.5.1** **ANLR-Panel** Resolution
SENSe3:PHASe:SETTLing:**TOUT**	**<nu>** 0.001 ...10 s	**2.6.5.1** **ANLR-Panel** Timeout

Command	Parameter	Section
SENSe3:PHASe:UNIT2	**DEG** **RAD** **DDEG** **DRAD** **S** **DS**	**2.4** **ANLR-Panel** Unit Ch2
SENSe4:DATA?	**<nu>** Query only	**3.15.8** **Result display**
SOURce:DIGital:FEED	**ADATa** **JITTer** **PHASe** **COMMon**	**2.5.3** **GEN-Panel** Src Mode → AUDIO DATA → JITTER ONLY → PHASE → COMMON ONLY
SOURce:DIGital:REFerence	**AZERo** **AONE**	**2.5.3** **GEN-Panel** Data → ALL ZERO → ALL ONE
SOURce:DIGital:SYNC:DELay	**<nu>**	**2.5.3.1** **GEN-Panel** PhaseToRef
SOURce:DIGital:SYNC:MODE	**V50** **V60** **WCLock** **IWCLock** **F1024**	**2.5.3** **GEN-Panel** Sync Mode → VIDEO 50 → VIDEO 60 → WORD CLK → WRD CLK INV → 1024 kHz
SOURce:DIGital:SYNC:SOURce	**GCLock** **AINPut** **RINPut** **SINPut**	**2.5.3** **GEN-Panel** Sync Out → GEN CLK → AUDIO IN → REF IN → SYNC IN
SOURce:EQUalize:CONTrol:POINts?	**<n>** 0 to 1023 Query only	**2.9.1.3** **No manual control**
SOURce:EQUalize:CONTrol[:DATA]	**<n>{,<n>}**	**2.9.1.3** **No manual control**
SOURce:FREQuency[1][:CWIFIXed]	**<nu>** Value range and units determined by instrument or function	**2.5.4.8** **GEN-Panel** UPPER FREQ
SOURce:FREQuency:DIFFerence	**<nu>** Value range and units determined by instrument or function	**2.5.4.8** **GEN-Panel** DIFF FREQ

Command	Parameter	Section
SOURce:**FREQ**uency:**MEAN**	**<nu>** Value range and units determined by instrument or function	**2.5.4.8** **GEN-Panel** MEAN FREQ
SOURce:**FREQ**uency:**MODE**	**CW** | **FIX**ed **SWE**ep1 **SWE**ep2 **LIST1** **LIST2**	**2.5.4.2** **GEN-Panel** SWEEP CTRL X Axis Z Axis
SOURce:**FREQ**uency:**OFFS**et:**STAT**e	**ON** **OFF**	**2.5.4.1** **GEN-Panel** Frq. Offset → + 1000 PPM → OFF
SOURce:**FREQ**uency:**REF**erence	**<nu>** 1 mHz to 1 MHz	**2.5.2** **GEN-Panel** Ref.Freq
SOURce:**FREQ**uency:**STAR**t **SOUR**ce:**FREQ**uency:**STOP**	**<nu>** Value range and units determined by instrument or function	**2.5.4.2** **GEN-Panel** FREQUENCY → Start → Stop
SOURce:**FREQ**uency[:CW|FIX**ed**]	**<nu>** Value range and units determined by instrument or function	**2.5.4.5** **GEN-Panel** FREQUENCY
SOURce:**FREQ**uency[<i>][:CW|FIX**ed**]	**<i>** 1 to 17 **<nu>** Value range and units determined by instrument or function	**2.5.4.4** **GEN-Panel** Freq No1 ...17
SOURce:**FREQ**uency[1][:CW|FIX**ed**]	**<nu>** ANALOG-Gen: 240 Hz to 21,75 kHz DIGITAL-Gen: 240 Hz to f_{max} f_{max} see 2.5.1	**2.5.4.7** **GEN-Panel** UPPER FREQ
SOURce:**FREQ**uency**2**[:CW|FIX**ed**]	**<nu>** 0 Hz to Nutzfreq / 8	**2.5.4.7** **GEN-Panel** LOWER FREQ
SOURce:**FUNC**tion:**MODE**	**EQU**alvoltage **DEF**inedvoltage **IEC**268 **IEC**118	**2.5.4.4** **GEN-Panel** Mode → EQUAL VOLT → DEFINE VOLT **2.5.4.1.1** **GEN-Panel** Mode → IEC 268 → IEC 118

Command	Parameter	Section
SOURce:**FUNC**tion[:SHAPe]	**SIN**usoid **MULT**isine **BURS**t **S2P**ulse **MDIS**t **DFD** **RAND**om **USER** **POL**arity	**2.5.4** **GEN-Panel** FUNCTION → SINE → MULTISINE → SINE BURST → SINE² BURST → MOD DIST → DFD → RANDOM → ARBITRARY → POLARITY
SOURce:**FUNC**tion[:SHAPe]	**SIN**usoid **MULT**isine **BURS**t **S2P**ulse **MDIS**t **DFD** **RAND**om **USER** **POL**arity **FSK**	**2.5.4** **GEN-Panel** FUNCTION → SINE → MULTISINE → SINE BURST → SINE² BURST → MOD DIST → DFD → RANDOM → ARBITRARY → POLARITY → FSK
SOURce:**INT**erval:**MODE**	**CW** | **FIX**ed **SWE**ep1 **SWE**ep2 **LIST1** **LIST2**	**2.5.4.2** **GEN-Panel** SWEEP CTRL X Axis Z Axis
SOURce:**INT**erval:**STAR**t	**<nu>** Value range and units determined by instrument or function	**2.5.4.1.3** **2.5.4.5** **2.5.4.6** **GEN-Panel** Start
SOURce:**INT**erval:**STOP**	**<nu>** Value range and units determined by instrument or function	**2.5.4.1.3** **2.5.4.5** **2.5.4.6** **GEN-Panel** Stop
SOURce:**INT**erval[:CW|FIXed]	**<nu>** Value range and units determined by instrument or function	**2.5.4.5** **2.5.4.6** **GEN-Panel** INTERVAL
SOURce:**LIST**:**DWEL**l	**<n>**{,**<n>**}	**2.9.1.3** **No manual control**
SOURce:**LIST**:**DWEL**l:**CONT**rol:**POIN**ts?	**<n>** 0 to 1023 Query only	**2.9.1.3** **No manual control**
SOURce:**LIST**:**DWEL**l:**CONT**rol[:DATA]	**<n>**{,**<n>**}	**2.9.1.3** **No manual control**

Command	Parameter	Section
SOURce:LIST:DWELl:POINts?	**<n>** 0 to 1023 Query only	**2.9.1.3** **No manual control**
SOURce:LIST:FREQuency	**<n>{,<n>}**	**2.9.1.3** **No manual control**
SOURce:LIST:FREQuency:POINts?	**<n>** 0 to 1023 Query only	**2.9.1.3** **No manual control**
SOURce:LIST:INTerval	**<n>{,<n>}**	**2.9.1.3** **No manual control**
SOURce:LIST:INTerval:POINts?	**<n>** 0 to 1023 Query only	**2.9.1.3** **No manual control**
SOURce:LIST:ONTime	**<n>{,<n>}**	**2.9.1.3** **No manual control**
SOURce:LIST:ONTime:POINts?	**<n>** 0 to 1023 Query only	**2.9.1.3** **No manual control**
SOURce:LIST:VOLTage	**<n>{,<n>}**	**2.9.1.3** **No manual control**
SOURce:LIST:VOLTage:POINts?	**<n>** 0 to 1023 Query only	**2.9.1.3** **No manual control**
SOURce:LOWDistortion	**ON** **OFF**	**2.5.4.1** **2.5.4.3** **GEN-Panel** Low Dist → ON → OFF
SOURce:MULTisine:COUNt	**<n>** 1 to 17	**2.5.4.4** **GEN-Panel** No of Sine
SOURce:MULTisine:MODE	**EQU**alvoltage **DEF**inedvoltage	**2.5.4.4** **GEN-Panel** Mode → EQUAL VOLT → DEFINE VOLT
SOURce:O33	'O33 ID code'	**No manual control**
SOURce:OFF:MODE	**SWEep2 | LIST2**	**2.5.4.2** **GEN-Panel** Z Axis → OFF

Command	Parameter	Section
SOURce:**ONT**ime:**DEL**ay	**<nu>** 0...60 s	**2.5.4.5** **2.5.4.6** **GEN-Panel** BurstOnDel
SOURce:**ONT**ime:**MODE**	**CW** | **FIX**ed **SWEep1** **SWEep2** **LIST1** **LIST2**	**2.5.4.2** **GEN-Panel** SWEEP CTRL X Axis Z Axis
SOURce:**ONT**ime:**STAR**t **SOUR**ce:**ONT**ime:**STOP**	**<nu>** Value range and units determined by instrument or function	**2.5.4.2** **2.5.4.5** **2.5.4.6** **GEN-Panel** Start Stop
SOURce:**ONT**ime[:CW|FIX**ed**]	**<nu>** Value range and units determined by instrument or function	**2.5.4.5** **GEN-Panel** ON TIME
SOURce:**PHAS**e[**<i>**][:ADJust]	**<i>** 1 to 17 **<nu>** 0 to 360 °	**2.5.4.4** **GEN-Panel** Phas No 1...17
SOURce:**PROT**ocol	**OFF** **STAT**ic **ENH**anced	**2.5.3.2** **ANA-Panel** PROTOCOL → PANEL OFF → STATIC → ENHANCED
SOURce:**PROT**ocol:**RCH**annelstatus	**ZERO** **LEQ**ual **AES3** **CRC** **RAW**	**2.5.3.2** **GEN-Panel** Ch Stat. R → ZERO → EQUAL L → FILE+AES3 → FILE+CRC → FILE
SOURce:**PROT**ocol:**UMOD**e	**ZERO** **FILE**	**2.5.3.2** **GEN-Panel** User Mode → ZERO → FILE DEF
SOURce:**RAND**om:**DOM**ain	**FREQ**uency **TIME**	**2.5.4.9** **GEN-Panel** Domain → FREQ → TIME
SOURce:**RAND**om:**FREQ**uency:**LOW**er **SOUR**ce:**RAND**om:**FREQ**uency:**UPP**er	**<nu>** Value range and units determined by instrument or function	**2.5.4.9** **GEN-Panel** Lower Freq Upper Freq

Command	Parameter	Section
SOURce:**RAND**om:**PDF**	**GAUS**sian **TRI**angle **RECT**angle	**2.5.4.1.1** **2.5.4.9** **GEN-Panel** PDF → GAUSS → TRIANGLE → RECTANGLE
SOURce:**RAND**om:**SHAP**e	**WHIT**e **PINK** **TOCT**ave **ARB**itrary	**2.5.4.9** **GEN-Panel** Equalizatn → WHITE → PINK → THIRD OCT → FILE
SOURce:**RAND**om:**SPAC**ing:**FREQ**uency	**<nu>** Lower limit value: analog = 2.93 Hz digital = sampling frequency / 16384	**2.5.4.4** and **2.5.4.9** **GEN-Panel** Spacing
SOURce:**RAND**om:**SPAC**ing:**MODE**	**ATR**ack **USER**defined	**2.5.4.4** and **2.5.4.9** **GEN-Panel** Spacing → ANLR TRACK → USER DEF
SOURce:**SIN**usoid:**DITH**er	**<nu>** 0 to 1 FS	**2.5.4.1.1** **GEN-Panel** Dither
SOURce:**SIN**usoid:**DITH**er:**STAT**e	**ON** **OFF**	**2.5.4.1.1** **GEN-Panel** Dither → ON → OFF
SOURce:**SWE**ep ...		3.10.1.4 GEN-Panel
SOURce:**SWE**ep:**DWEL**l	**<nu>** 10 ms to 1000 s	**2.5.4.2** **GEN-Panel** Dwell
SOURce:**SWE**ep:**FREQ**uency:**POIN**ts	**<n>** 2 to 1024	**2.5.4.2** **GEN-Panel** Points
SOURce:**SWE**ep:**FREQ**uency:**SPAC**ing	**LIN**ear **LOG**arithmic	**2.5.4.2** **GEN-Panel** Spacing
SOURce:**SWE**ep:**FREQ**uency:**STEP**	**<nu>**	**2.5.4.2** **GEN-Panel** Step
SOURce:**SWE**ep:**INT**erval:**POIN**ts	**<n>** 2 to 1024	**2.5.4.1.3** **GEN-Panel** Points

Command	Parameter	Section
SOURce:**SWE**ep:**INT**erval:**SPAC**ing	**LIN**ear **LOG**arithmic	**2.5.4.1.3** **GEN-Panel** Spacing → LIN → LOG
SOURce:**SWE**ep:**INT**erval:**STEP**	**<nu>** Value range and units determined by instrument or function	**2.5.4.1.3** **GEN-Panel** Step
SOURce:**SWE**ep:**MODE**	**MAN**ual **AUTO**	**2.5.4.2** **GEN-Panel** Sweep Ctrl
SOURce:**SWE**ep:**NEXT**step	**DWEL**l **ASYN**c **LIST**	**2.5.4.2** **GEN-Panel** Next Step → ANLR SYNC → DWELL VALUE → DWELL FILE
SOURce:**SWE**ep:**ONT**ime:**POIN**ts	**<n>** 2 to 1024	**2.5.4.2** **GEN-Panel** Points
SOURce:**SWE**ep:**ONT**ime:**SPAC**ing	**LIN**ear **LOG**arithmic	**2.5.4.2** **GEN-Panel** Spacing → LIN → LOG
SOURce:**SWE**ep:**ONT**ime:**STEP**	**<nu>** Value range and units determined by instrument or function	**2.5.4.1.3** **GEN-Panel** Step
SOURce:**SWE**ep:**VOLT**age:**POIN**ts	**<n>** 2 to 1024	**2.5.4.2** **GEN-Panel** Points
SOURce:**SWE**ep:**VOLT**age:**SPAC**ing	**LIN**ear **LOG**arithmic	**2.5.4.2** **GEN-Panel** Spacing → LIN → LOG
SOURce:**SWE**ep:**VOLT**age:**STEP**	**<nu>** Value range and units determined by instrument or function	**2.5.4.2** **GEN-Panel** Step
SOURce:**VOLT**age:**CRES**tfactor	**<n>** 1 to 100	**2.5.4.4** **GEN-Panel** Crest Fact
SOURce:**VOLT**age:**CRES**tfactor:**MODE**	**MIN**imized **DPH**ase **VAL**ue	**2.5.4.4** **GEN-Panel** Crest Fact → OPTIMIZED → DEFINE PHAS → VALUE

Command	Parameter	Section
SOURce:**VOLT**age:**EQU**alize:**POIN**ts?	<n> 0 to 1023 Query only	**2.9.1.3** **No manual control**
SOURce:**VOLT**age:**EQU**alize:**STAT**e	**ON** **OFF**	2.5.4.4 and 2.5.4.3 **GEN-Panel** Equalizer → ON → OFF
SOURce:**VOLT**age:**EQU**alize[:DATA]	<n>{,<n>}	**2.9.1.3** **No manual control**
SOURce:**VOLT**age:**EQU**alizer:**STAT**e	**ON** **OFF**	**2.5.4.4** **GEN-Panel** Equalizer → ON → OFF
SOURce:**VOLT**age:**LIM**it[:AMPLitude]	<nu> 0 to 20 V 0 to 1 FS	**2.5.2** **GEN-Panel** For Volt Range = AUTO, Max Volt is displayed, for Volt Range = FIX, a numeric value.
SOURce:**VOLT**age:**LOWL**evel	<nu> 0 to SOUR:VOLT	**2.5.4.5** **GEN-Panel** Low Level
SOURce:**VOLT**age:**MODE**	**CW** | **FIX**ed **SWEep1** **SWEep2** **LIST1** **LIST2**	**2.5.4.2** **GEN-Panel** SWEEP CTRL X Axis Z Axis
SOURce:**VOLT**age:**RANG**e:**AUTO**	**ON** **OFF**	**2.5.2** **GEN-Panel** Volt Range → AUTO → FIX
SOURce:**VOLT**age:**RAT**io	<n> 1 to 10	**2.5.4.7** **GEN-Panel** VOLT LF:UF
SOURce:**VOLT**age:**REF**erence	<nu> 1 mV to 1 MV	**2.5.2** **GEN-Panel** Ref.Volt
SOURce:**VOLT**age:**STAR**t	<nu> Value range determined by instrument or function	**2.5.4.2** **GEN-Panel** VOLTAGE → Start

Command	Parameter	Section
SOURce:**VOLT**age:**STOP**	**<nu>** Value range determined by instrument or function	**2.5.4.2** **GEN-Panel** VOLTAGE → Stop
SOURce:**VOLT**age:**TOT**al:**GAIN**	**<nu>**	**2.5.4.4** **GEN-Panel** TOTAL GAIN
SOURce:**VOLT**age:**TOT**al:**RMS?**	**<nu>** 0 V to 20 V	**2.5.4.4** **2.5.4.9** **2.5.4.10** **GEN-Panel** TOTAL RMS
SOURce:**VOLT**age:**TOT**al[:LEVel|AMPLitude]	**<nu>** **Analog instruments**: Output = UNBAL: 0 to 14,142 V (OUTPUT = BAL: 0 ...16.971 V **Digital instrument**: Src Mode = AUDIO DATA: 0 to 1 FS Src Mode = JITTER ONLY: 0 UI to 2,5 UI Src Mode = PHASE: 0 to 1 FS Src Mode = COMMON ONLY: 0 V to 10 V	**2.5.4.4** Query only **2.5.4.7** **2.5.4.8** **2.5.4.9** **2.5.4.10** **GEN-Panel** TOTAL VOLT
SOURce:**VOLT**age[:LEVel|AMPLitude]	**<nu>** 0 to 12 V 0 to 24 V 0 to 1 FS	**2.5.4.3** **2.5.4.5** **2.5.4.6** **2.5.4.11** **2.5.4.12** **GEN-Panel** VOLTAGE
SOURce:**VOLT**age[:LEVel|AMPLitude]:**OFFS**et	**<n>** -5 V to 5 V -10 V to 10 V -1 FS to 1 FS	**2.5.4.1.1** **GEN-Panel** DC Offset
SOURce:**VOLT**age[:LEVel|AMPLitude]:**OFFS**et:**STAT**e	**OFF** **ON**	**2.5.4.1.1** **GEN-Panel** DC Offset → OFF → ON
SOURce:**VOLT**age[**<i>**][:LEVel|AMPLitude]	**<i>** 1 to 17 **<nu>** Analog instr.: OUTP:TYPE UNB 0 to 10 V Analog instr.: OUTP:TYPE BAL 0 to 20 V Digital instrument: 0 to 1 FS	**2.5.4.4** **GEN-Panel** Volt No 1 to 17

Command	Parameter	Section
SOURce2:**FREQ**uency:**MODE**	**CW** | **FIX**ed **SWE**ep1 **LIST1**	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN: SWEEP CTRL X Axis
SOURce2:**FREQ**uency:**STAR**t	**<nu>** 10 Hz to 110 kHz	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN: FREQUENCY Start
SOURce2:**FREQ**uency:**STOP**	**<nu>** 10 Hz to 110 kHz	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN: FREQUENCY Stop
SOURce2:**FREQ**uency[:CW|FIX**ed**]	**<nu>** 10 Hz to 110 kHz	**2.5.5** **GEN-Panel** Abhängig von AUX GEN: → Anlg Freq → Comm Freq → JittPkFreq
SOURce2:**FUNC**tion	**OFF** **ANLG**out **COMM**on **JITT**er	**2.5.5** **GEN-Panel** **AUX GEN**: → OFF → ANALOG OUT → COMMON MODE → JITTER
SOURce2:**SWE**ep ...		**2.5.4.2 Sweeps** **GEN-Panel** AUX GEN:
SOURce2:**SWE**ep:**DWEL**l	**<nu>** 10 ms to 1000 s	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN: Dwell
SOURce2:**SWE**ep:**FREQ**uency:**POIN**ts	**<n>** 2 to 1024	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN: FREQUENCY Points
SOURce2:**SWE**ep:**FREQ**uency:**SPAC**ing	**LIN**ear **LOG**arithmic	**2.5.4.2** Sweeps **GEN-Panel** Spacing → LIN → LOG
SOURce2:**SWE**ep:**FREQ**uency:**STEP**	**<nu>** depending on STARt and STOP	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN FREQUENCY Step

Command	Parameter	Section
SOURce2:SWEep:MODE	**MANual** **AUTO**	**2.5.4.1.3** **GEN-Panel** AUX GEN Sweep Ctrl
SOURce2:SWEep:NEXTstep	**DWEL** **ASYN** **LIST**	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN: Next Step → ANLR SYNC → DWELL VALUE → DWELL FILE
SOURce2:SWEep:VOLTage:POINts	**<n>** 2 to 1024	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN VOLTAGE I AMPL Points
SOURce2:SWEep:VOLTage:SPACing	**LINear** **LOGarithmic**	**2.5.4.2** Sweeps **GEN-Panel** VOLTAGE I AMPL AUX GEN: ANALOG Spacing → LIN → LOG
SOURce2:SWEep:VOLTage:STEP	**<nu>** depending on STARt and STOP	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN VOLTAGE I AMPL Step
SOURce2:VOLTage:MODE	**CW I FIXed** **SWEep1** **LIST1**	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN SWEEP CTRL X Axis
SOURce2:VOLTage:STARt	**<nu>** 0 to 7.07 V 0 to 250 mUI	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN VOLTAGE I AMPL Start
SOURce2:VOLTage:STOP	**<nu>** 0 to 7.07 V 0 to 7.07 V 0 to 250 mUI	**2.5.4.2** Sweeps **GEN-Panel** AUX GEN VOLTAGE I AMPL Stop
SOURce2:VOLTage[:LEVel|AMPLitude]	**<nu>** 0 to 7.07 V 0 to 7.07 V 0 to 250 mUI	**2.5.5** **GEN-Panel** Abhängig von AUX GEN: → Anlg Ampl → Comm Ampl → JittPkAmpl

Command	Parameter	Section
STATus:**OPER**ation:**COND?**	<n> Query only	3.7.3.4 **No manual control**
STATus:**OPER**ation:**ENAB**le	<n> .... 0 0 1 0 0 1 0 0 ... .d7 d6 d5 d4 d3 d2 d1 d0 Example: d2 and d5 set: <n> = 36 (4 + 32)	3.7.3.4 **No manual control**
STATus:**OPER**ation:**NTR**ansition	<n>	3.7.3.4 **No manual control**
STATus:**OPER**ation:**PTR**ansition	<n>	3.7.3.4 **No manual control**
STATus:**OPER**ation[:EVENt]**?**	<n> Query only	3.7.3.4 **No manual control**
STATus:**PRES**et		3.7.5 **No manual control**
STATus:**QUES**tionable:**COND?**	<n> Query only	3.7.3.5 **No manual control**
STATus:**QUES**tionable:**ENAB**le	<n>	3.7.3.5 **No manual control**
STATus:**QUES**tionable:**NTR**ansition	<n>	3.7.3.5 **No manual control**
STATus:**QUES**tionable:**PTR**ansition	<n>	3.7.3.5 **No manual control**
STATus:**QUES**tionable[:EVENt]**?**	<n> Query only	3.7.3.5 **No manual control**
STATus:**XQUE**stionable:**COND?**	<n> Query only	3.7.3.6 **No manual control**
STATus:**XQUE**stionable:**ENAB**le	<n>	3.7.3.6 **No manual control**
STATus:**XQUE**Stionable:**NTR**ansition	<n>	3.7.3.6 **No manual control**

Command	Parameter	Section
STATus:**XQUE**stionable:**PTR**ansition	<n>	**3.7.3.6 No manual control**
STATus:**XQUE**stionable[:EVENt]**?**	<n> Query only	**3.7.3.6 No manual control**
SYSTem:**AHAR**dware:**VERS**ion**?**	**ABO**ard **ACOD**e Query only Query: SYST:AHAR:VERS? ABO SYST:AHAR:VERS? ACOD The response is either the number of a version (eg 0.01) or -NA- (Not Available) if the board is not installed.	**2.15.7 OPTIONS-Panel** VERSIONS ------ Anlg Board code
SYSTem:**BEEP**er:**STAT**e	**ON** **OFF**	**2.15.2 OPTIONS-Panel** Beeper → ON → OFF
SYSTem:**COMM**unicate:**GPIB**:**ADDR**ess	<n> 0 to 31	**2.15.1 OPTIONS-Panel** UPL IECadr
SYSTem:**COMM**unicate:**GTL**		**LOCAL-Tastendruck**
SYSTem:**COMM**unicate:**SER**ial**2**: **CONT**rol	**RTS** **XON**	2.15.1 **OPTIONS-Panel** Handshake → RTS/CTS → XON/XOFF
SYSTem:**COMM**unicate:**SER**ial**2**: **FEED**:**BITS**	<n> n = 7 I 8	2.15.1 **OPTIONS-Panel** Data Bits → 7 → 8
SYSTem:**COMM**unicate:**SER**ial**2**:**FEED**:**BAUD**	<n> n = **2400** **3600** **4800** **7200** **9600** **19200** **38400** **56000**	2.15.1 **OPTIONS-Panel** Baud Rate → 2400 Baud → 3600 Baud → 4800 Baud → 7200 Baud → 9600 Baud → 19200 Baud → 38400 Baud → 56000 Baud

Command	Parameter	Section
SYSTem:**COMM**unicate:**SER**ial**2**:**FEED**:**PAR**ity[:TYPE]	**NONE** **EVEN** **ODD**	2.15.1 **OPTIONS-Panel** Parity → NONE → EVEN → ODD
SYSTem:**COMM**unicate:**SER**ial**2**:**FEED**:**SBIT**s	**<n>** n = 1 I 2	2.15.1 **OPTIONS-Panel** Stop Bits → 1 → 2
SYSTem:**DHAR**dware:**VERS**ion**?**	**CPU**board **DBO**ard Query only Query: SYST:DHAR:VERS? CPU SYST:DHAR:VERS? DBO The response is the number of a version (eg 0.05).	2.15.7 **OPTIONS-Panel** VERSIONS ------ CPU Board Dig. Board
SYSTem:**DISP**lay:**READ**ing:**RATE**	**MAXS**peed **FSTS**peed **MEDS**peed **SLWS**peed	2.15.5 **OPTIONS-Panel** Read Rate → MAX SPEED → 6/s → 3/s → 1/s
SYSTem:**DISP**lay:**READ**ing:**RES**olution	**<n>**	2.15.5 **OPTIONS-Panel** Read Resol
SYSTem:**DISP**lay:**TRAC**e[]:**LOAD**	**MAN**ual **DEF**ault **ACOL**or **ALIN**e	**2.15.5.4** **OPTIONS-Panel** Scan conf → MANUAL → DEFAULT → AUTO COLOR → AUTO LINE
SYSTem:**DISP**lay:**TRAC**e[1I**2**]:**COL**or	**GRE**en **YELL**ow **BLUE** **CYAN** **MAG**enta **WHIT**e **BLAC**k **DGR**ay **LGR**ay	**2.15.5.4** **OPTIONS-Panel** Color (A) / (B) → GREEN → YELLOW → BLUE → CYAN → MAGENTA → WHITE → BLACK → DARK GRAY → LIGHT GRAY

Command	Parameter	Section
SYSTem:**DISP**lay:**TRAC**e[1|2]:**LINE**	**SSOL**id **SD** **SP** **SPD** **DSOL**id **DD** **DP** **DPD**	**2.15.5.4** **OPTIONS-Panel** Line (A) / (B) → ———— → – – – – – → . . . . . . → . – . – . – → ═══ → ====== → : : : : : : → : = : = : =
SYSTem:**DISP**lay:**TRAC**e[1|2]:**SEL**ect	<n> 1 ...17	**2.15.5.4** **OPTIONS-Panel** Scannr.(A) Scannr.(B)
SYSTem:**ERR**or?	<n> Query only	3.3.2 **No manual control**
SYSTem:**INFO**text:**STAT**e	**ON** **OFF**	2.9.1.1 **FILE-Panel** Info Displ → ON → OFF
SYSTem:**KEY**:**RDEL**ay	<nu> 0.25 to 1.0 s	**2.15.3** **OPTIONS-Panel** Rep Delay
SYSTem:**KEY**:**RRAT**e	<nu> 0 to 50 Hz	**2.15.3** **OPTIONS-Panel** Reptn Rate
SYSTem:**LSP**eed	**FAST** **SLOW**	**No manual control**
SYSTem:**OPT**ions:**VERS**ion?	**LDG** alias **B1** **REMO**te alias **B4** **DAUD**io alias **B2** **SPE**aker alias **B5** **DAPR**otocol alias **B21** **DAJ**Itter alias **B22** **SQCO**ntrol alias **B10** B33 B6 Query only Query-Form z.B.: SYST:OPT:VERS? LDG The response is either the number of an option (eg 0.01), INST or -NA- (Not Available) if the board or option are not installed.	**2.15.7** **2.6.6** **OPTIONS-Panel** OPTIONS ------- B1 Low Dist B4 Rem Ctrl B2 DigAudio B5 Speaker B21 DA Prot B22 DA Jitt B10 Seq Ctrl TU-T O33 B6 Coher
SYSTem:**PAR**ameter:**LINK**	<n> 0 to 2047	**2.15.7** **OPTIONS-Panel** Param. Link

Command	Parameter	Section
SYSTem:**PHON**e	**SPKC** **PERM**	**2.6.6** **ANLR-Panel** Phone Out → SPKPhone → PERMANENT
SYSTem:**PRIN**t	**TRAC**e1 **TRAC**e2 **EQU**alize **ERR**ors **DWEL**l **LIML**ower **LIMU**pper **LIST1** **LIST2** **TR1A**nd2 **OFF**	**2.14.5** **OPTIONS-Panel** PRINT Type → TRACE A → TRACE B → EQUALIZATN → LIM REPORT → DWELL VALUE → LIM LOWER → LIM UPPER → X AXIS → Z AXIS → TRACE A+B → OFF
SYSTem:**PROG**ram:**EXEC**ute	**'filename'**	**2.16** **OPTIONS-Panel** Exec Macro <filename>
SYSTem:**PROG**ram:**POIN**ts?	**<n>** 0 to 1024 Query only	**No manual control**
SYSTem:**PROG**ram[:DATA]	**<n>**{,**<n>**}	**No manual control**
SYSTem:**SOFT**ware:**VERS**ion**?**	**SOFT**ware **SETU**p Query only Query: SYST:SOFT:VERS? SOFT SYST:SOFT:VERS? SETU The response is the number of a version (eg 3.05).	**2.15.7** **OPTIONS-Panel** VERSIONS ------ Software Setup
SYSTem:**SPE**aker:**GAIN**	**<nu>** -120 ...120 dB	**2.6.6** **ANLR-Panel** Pre Gain

Command	Parameter	Section
SYSTem:**SPE**aker:**SOUR**ce	**OFF** **INP1** **INP2** **IN1**And2 **FNC1** **FNC2** **FN1**And2 **AES1** **AES2** **AE1**And2	**2.6.6** **ANLR-Panel** SPEAKER → OFF → INPUT Ch1 → INPUT JITT → INPUT COMM → INPUT Ch2 → INPUT Ch1&2 → FUNCT Ch1 → FUNCT Ch2 → FUNCT Ch1&2 → DIG IN Ch1 → DIG IN Ch2 → DIG Ch1&2
SYSTem:**SPE**aker:**VOL**ume	**<nu>** 0...100 %	**2.6.6** **ANLR-Panel** Skp Volume
SYSTem:**SPE**aker[:STATe]	**ON** **OFF**	**2.6.6** **ANLR-Panel** LOCAL-Taste
SYSTem:**VERS**ion**?**	**<n>** Query only	**2.15.7** **No manual control**
TRACe:**POIN**ts**?**	**CREF**erence1 Query only Query: TRAC:POIN? CREF1 Query response <n> = 0 to 1023	**2.9.1.3** **No manual control**
TRACe:**POIN**ts**?**	CREFerence2 Query only Query: TRAC:POIN? CREF2 Query response: <n> = 0 to 1023	**2.9.1.3** **No manual control**
TRACe:**POIN**ts**?**	**REF**erence1 Query only Query: TRAC:POIN? REF1 Query response: <n> = 0 to 1023	**2.9.1.3** **No manual control**
TRACe:**POIN**ts**?**	**REF**erence2 Query only Query: TRAC:POIN? REF2 Query response: <n> = 0 to 1023	**2.9.1.3** **No manual control**

Command	Parameter	Section
TRACe:POINts?	**TRACe2** Query only Query: TRAC:POIN? TRAC2 Query response: <n> = 0 to 1023 Query only	**2.9.1.3** **No manual control**
TRACe:POINts? LIST1	**LIST1** Query only Query: TRAC:POIN? LIST1 Query response: <n> = 0 to 1023	**2.9.1.3** **No manual control**
TRACe:POINts? LIST2	**LIST2** Query only Query: TRAC:POIN? LIST2 Query response: <n> = 0 to 1023	**2.9.1.3** **No manual control**
TRACe:POINts? TRACe1	**TRACe1** Query only Query: TRAC:POIN? TRAC1 Query response: <n> = 0 to 1023 Query only	**2.9.1.3** **No manual control**
TRACe[:DATA]	**LIST1,<n>{,<n>}** Queryform: TRACe? LIST1	**2.9.1.3** **No manual control**
TRACe[:DATA]	**LIST2,<n>{,<n>}** Queryform: TRACe? LIST2	**2.9.1.3** **No manual control**
TRACe[:DATA]	**REFerence1,<n>{,<n>}** Queryform: TRACe? REF1	**2.9.1.3** **No manual control**
TRACe[:DATA]	**REFerence2,<n>{,<n>}** Queryform: TRACe? REF2	**2.9.1.3** **No manual control**
TRACe[:DATA]	**TRACe1,<n>{,<n>}** Queryform: TRACe? TRAC1	**2.9.1.3** **No manual control**
TRACe[:DATA]	**TRACe2,<n>{,<n>}** Queryform: TRACe? TRAC2	**2.9.1.3** **No manual control**
TRACe[:DATA] **CREFerence1,**	**<n>{,<n>}** Queryform: TRACe? CREF1	**2.9.1.3** **No manual control**

Command	Parameter	Section
TRACe[:DATA] **CREF**erence**2,**	<n>{,<n>} Queryform: TRACe? CREF2	**2.9.1.3** **No manual control**
TRIGger:**CHAN**nel	**CH1** **CH2** **GENB**urst	**2.6.5.14** **ANLR-Panel** Trig Src → CHAN 1 → CHAN 2 → GEN BURST
TRIGger:**COUN**t	<nu> 2 to 1024	**2.6.4** **ANLR-Panel** Points
TRIGger:**DEL**ay	<nu> 0 to 10 s	**2.6.4** **ANLR-Panel** Delay
TRIGger:**FREQ**uency:**VAR**iation	<nu> > 0.1 to 50%	**2.6.4** **ANLR-Panel** Variation
TRIGger:**LEV**el	<nu> Analog instruments -50 V to 50 V Digital instrument -1 FS to 1 FS	**2.6.5.14** **ANLR-Panel** Trig Level
TRIGger:**SLOP**e	**POS**itive **NEG**ative	**2.6.5.14** **ANLR-Panel** Trig Slope → RISING → FALLING
TRIGger:**SOUR**ce	**IMM**ediate **TIM**er **CH1F**req **CH2F**req **CH1L**evel **CH2L**evel **CH1T**rigger **CH2T**rigger **TCH**art **CH1R**apidfreq **CH2R**apidfreq **CH1E**dgetrigger **CH2E**dgetrigger	**2.6.4** **ANLR-Panel** START COND → AUTO → TIME → CH1Freq | CH2Freq → CH1Level | CH2Level → LEV TRG CH1 | LEV TRG CH2 → TIME CHART → FRQ FST CH1 → FRQ FST CH2 → EDG TRG CH1 → EDG TRG CH2
TRIGger:**TIM**er	<nu> 10 ms to 2000 s	**2.6.4** **ANLR-Panel** Timetick
TRIGger:**VOLT**age:**VAR**iation	<nu> > 0.1 to 50%	**2.6.4** **ANLR-Panel** Variation

3.12 IEC/IEEE-Bus Interface

The UPL is equipped with an IEC/IEEE-bus interface as a standard. The mating 25-pin connector according to standard IEC 625.1/IEEE 488 is at the rear of the instrument. A controller for remote control can be connected via the interface. Interconnection is made via a shielded cable.

3.12.1 Interface Characteristics

- 8-bit parallel data transfer
- bidirectional data transfer
- three line handshake
- high data transfer rate of max. 350 kByte/s
- up to 15 devices can be connected
- maximum length of interconnecting cable 15 m (single connection 2m)
- wired OR if several instruments are interconnected in parallel.

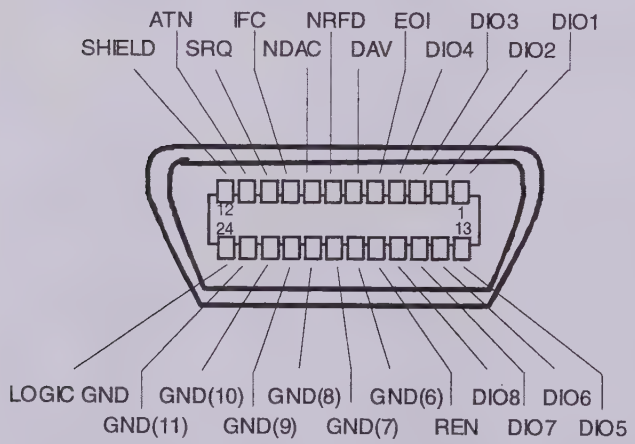


Fig. 3-7 Pin assignment of IEC/IEEE-bus interface

3.12.2 Bus Lines

1. **Data bus with 8 lines DIO 1 to DIO 8.**
   The transmission is bit-parallel and byte-serial in the ASCII/ISO code. DIO1 is the bit of lowest order, DIO8 the bit of highest order.

2. **Control bus with 5 lines.**
   IFC (Interface Clear),
   active low resets the interfaces of all connected instruments to the default setting.

   ATN (Attention),
   active low signals the transmission of interface messages
   inactive high signals the transmission of device-dependent messages.

SRQ (Service Request),
active low enables a device connected to send a service request to the controller.

REN (Remote Enable),
active low permits the switchover to remote control.

EOI (End or Identify),
has two functions in connection with ATN:
active low marks the end of data transmission with ATN = HIGH
active low triggers a parallel poll with ATN = LOW.

3. **Handshake Bus mit drei Leitungen.**
DAV (Data Valid),
active low signals a valid data byte on the data bus.

NRFD (Not Ready For Data),
active low signals that one of the devices connected is not ready for data transfer.

NDAC (Not Data Accepted),
active low as long as the instrument connected is accepting the data present on the data bus.

3.12.3 Interface Functions

Instruments which can be remote-controlled via IEC/IEEE bus can be equipped with different interface functions. Table A-1 lists the interface functions appropriate for the UPL.

Table 3-10 Interface functions

Control character	Interface function
SH1	Handshake source function (source handshake)
AH1	Handshake drain function (acceptor handshake)
L3..L4/LE3..LE4	Listener function.
T5..T8/TE5..TE8	Talker function, ability to respond to serial poll
SR1	Service request function
PP1	Parallel poll function
RL1	Remote/Local switchover function
DC1	Resetting function (Device Clear)
DT1	Trigger function (Device Trigger)
C1...C27	Controller function (with optional software UPL-B10only)

3.13 Interface Messages

Interface messages are transmitted to the UPL on the data lines, with the attention line being active (LOW). They enable the communication between instrument and controller.Das Parsen von Befehlen entfällt, dadurch wird eine hohe Verarbeitungsgeschwindigkeit erreicht.

3.13.1 Common Commands

The common commands are encoded in the range 10 through 1F hex. They are effective for all instruments connected to the bus without addressing them before.

Table 3-11 Common commands

Command	BASIC command for R&S controllers	Effect on UPL
DCL (Device Clear)	IECDCL	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
IFC (Interface Clear)	IECIFC	Resets the interfaces to the default setting.
LLO (Local Lockout)	IECLLO	The REM/LOCAL key is disabled.
SPE (Serial Poll Enable)	IECSPE	Ready for serial poll
SPD (Serial Poll Disable)	IECSPD	End of serial poll
PPU (Parallel Poll Unconfigure)	IECPPU	End of the parallel-poll state

3.13.2 Addressed Commands

The addressed commands are encoded in the range 00 through 0F hex. They are only effective for instruments addressed as listeners.

Table 3-12 Addressed commands

Command	BASIC command for R&S controllers	Effect on UPL
SDC (Selected Device Clear)	IECLAD 20: IECSDC	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
GET (Group Execute Trigger)	IECLAD 20: IECGET	Triggers all actions which are waiting for a trigger event. This command is identical with the commands INIT and *TRG.
GTL (Go to Local)	IECLAD 20: IECGTL	Transition to the "Local" state (manual control)
PPC (Parallel Poll Configure)	IEC PCON 20,1,6	Configure instrument for parallel poll In the command to the left, the UPL with an address of 20 is reporting a 1 on line 6.

3.14 List of Error Messages

The following list contains error messages which can be obtained via IEC/IEEE bus or in manual operation. Negative error numbers are SCPI-defined. The positive error number "111" marks device-specific errors.

When and how is the error queue output?

If the controller does not succeed in transmitting a command to UPL, an error message appears in the information line on the screen and a short signal can be heard.

This error message can be indicated in the control program by outputting the error queue after every command sent to UPL. This should be controlled by SRQ, i.e. only when bit 3 (Device Dependent Error), bit 4 (Execution Error) or bit 5 (Command Error) of the event status register is set, but can also happen at any location in the control program.
If no error has been detected, the message is
0, "No Error"

Example:

```
1000Errqueue:
1010 IEC OUT 20,"SYST:ERR?":                    ' Output error queue until it is empty!
1020 IEC IN 20,E$.                              ' Read error information
1030 IF LEFT$(E$,1)="0" THEN RETURN:            ' 0, "No Error", error queue empty!
1040 PRINT "Contents of error queue:"; E$:GOTO Errqueue
```

The table contains the error number in the left-hand column. In the right-hand column, the error text being entered into the error/event queue or being displayed is printed in bold face. Below the error text, there is an explanation as to the respective error.

3.14.1 SCPI-Specific Error Messages

No Error

Error number	**Error query response** Explanation
0	**No error** This message is output if the error queue is completely empty.

3.14.2 Command Error

Command error — sets bit 5 in the ESR register.

Error number	**Error query response** Explanation
-100	**Command Error** The command is faulty or invalid.
-101	**Invalid Character** A syntactic element contains a character which is invalid for that type. Example: A header containing an ampersand, "SOURCE&".
-102	**Syntax error** An unrecognized command or data type was received. Example: A string was received when the device does not accept strings.
-103	**Invalid separator** The device was expecting a separator and received an illegal character. Example: The semicolon was omitted after a program message unit.
-104	**Data type error** The device recognized a data element different than one allowed. Example: Numeric or string data are expected but block data was received.
-105	**GET not allowed** A Group Execute Trigger (GET) was received within a program message.
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The header is syntactically correct, but it is undefined for the UPL. Example: *XYZ is not defined for any device.
-114	**Header suffix out of range** A nonheader character has been encountered in the header element parsed by the device. Example: SOURce3 is not defined for any device.
-123	**Exponent too large** The magnitude of the exponent is larger than 320000.
-124	**Too many digits** The mantissa of a decimal numeric data element contains more than 255 digits (excluding leading zeros).
-128	**Numeric data not allowed** A legal numeric data element was received, but the device does not accept one in this position for the header. Example: Command SOURce:FREQuency:MODE requires the indication of a text parameter.
-131	**Invalid suffix** The suffix is inappropriate for this device. Example: nHz is not defined?
-134	**Suffix too long** The suffix contains more than 12 characters.
-138	**Suffix not allowed** A suffix was received after a numeric element which does not allow suffixes. Example: Command *RCL does not permit indicating a suffix.
-141	**Invalid character data** Either the character data element contains an invalid character or the particular element received is not valid for the header. Example: Write error with parameter indication; SOURce:FREQuency:MODE FIKSed.

Command error (cont.)

Error number	Error query response Explanation
-144	**Character data too long** The character data element contains more than 12 characters.
-148	**Character data not allowed** A legal character data element was encountered where prohibited by the device. Example: Command *RCL requires the indication of a number.
-151	**Invalid string data** A string data element was expected, but was invalid for some reason. Example: An END message was received before the terminal quote character.
-158	**String data not allowed** A legal string data element was encountered where prohibited by the device.
-161	**Invalid block data** A block data element was expected, but was invalid for some reason. Example: An END message was received before the length was satisfied.
-168	**Block data not allowed** A legal block data element was encountered where prohibited by the device.
-178	**Expression data not allowed** A legal expression data element was encountered where prohibited by the device.

3.14.3 Execution Error

Execution error — sets bit 4 in the ESR register.

Error number	Error query response Explanation
-200	**Execution error** An error occurred when executing a received command.
-220	**Parameter error** A program data element related error occurred.
-221	**Settings conflict** A legal program data element was parsed but could not be executed due to the current device state.
-222	**Data out of range** The received data element was syntactically correct but could not be executed because the value was outside the legal range as defined by the device. Example: Command TRIG:DEL only permits entries in the range of 50 ms to 10 sec.
-241	**Hardware missing** A legal program command or query could not be executed because of missing device hardware; for example, an option was not installed.

3.14.4 Device-Specific Error

Device-specific Error — sets bit 3 in the ESR register.

Error number	Error query response Explanation
-300	**Device-specific error** Generic device-dependent error for devices that cannot detect more specific errors.

3.14.5 Query Error

Query Error — sets bit 2 in the ESR register.

Error number	Error query response Explanation
-400	**Query error** Generic device-dependent query error for devices that cannot detect more specific errors.
-420	**Query UNTERMINATED** A condition causing an UNTERMINATED query error occurred. Example: The device was addressed to talk and an incomplete program message was received.
-430	**Query DEADLOCKED** A condition causing an DEADLOCKED query error occurred. Example: Both input buffer and output buffer are full and the device cannot continue.

3.14.6 UPL-Specific Error Messages

Device-specific Error — sets bit 3 in the ESR register.

Error number	Error query response Explanation
111	After the error queue has been output, all device-dependent errors are shown with the code number 111 and a self-explanatory text having a maximum length of 50 characters, e.g. 111, „Device dep. error; Insufficient disk space! Cannot write file".

3.15 Examples of IEC/IEEE-Bus Programming (Hints and Program Examples)

The examples illustrate UPL programming and may be taken as a basis for solving more complex programming tasks.

All programming examples for IEC/IEEE-bus control in the path C:\UPL\IEC EXAM\EXAM1.BAS ff and those of the UPL software are written in R&S BASIC.

These examples can be run directly on a controller using a suitable IEC/IEEE-bus card and R&S BASIC (see (siehe 3.15.1, R&S BASIC). Files with the extension .SAC are setup files requiring the program examples for setting the UPL. Files with the extension .TXT give the program code of the examples as ASCII file so that they can be accessed with any editor.

If other languages are used for controlling the UPL by means of IEC/IEEE commands, the given sequence of commands may be used but for a few exceptions, as it is independent of the programming language.

3.15.1 R&S BASIC

The following program routines and examples and those contained in the UPL software are ready for use provided R&S BASIC and the R&S IEC/IEEE-bus card have been installed in the controller.

Note:

*R&S BASIC and the R&S IEC/IEEE-bus interface card may be ordered from your local sales engineer under the designation **PAT-B1, Order No. 1007.1150.02***

3.15.2 IEC/IEEE-Bus Control after Power-Up

After UPL power-up, messages may be displayed which have to be acknowledged using the ENTER or CANCEL key. If the instrument is to be remote-controlled after power-up irrespective of any messages displayed, it is recommended to start the UPL with the aid of the command line parameter "-r". In this case messages do not require to be acknowledged by a keystoke, the UPL is started with a suitable setup and immediately ready for remote control.

Example: C:\UPL\UPL_UI-r <CR>

3.15.3 Command Logging - Converting UPL-B10 Commands into IEC/IEEE-Bus Commands

All commands required for setting the UPL or for measurements are listed in section 3.10 IEC-bus Commands and section 3.11 Alphabetical List of IEC-bus Commands of the UPL manual. To avoid a tedious search for the commands required, the Universal Sequence Controller, UPL-*B10*, which is simply called *B10* below and available as an option, permits all manual setting procedures to be stored as *B10* commands and to be converted into the IEC/IEEE-bus control program.

Note:

*The Universal Sequence Controller option UPL-B10 may be ordered from your local sales engineer under the **Order No. 1078.3856.02**. For installation please refer to the Installation Instruction enclosed with Option UPL-B10.*

The procedure is explained by way of a sweep with subsequent display of the sweep curve:

- Prior to recording the desired command sequence, press key F2 to activate command logging ("**logging on**" displayed at bottom right). All settings performed subsequently in the UPL are recorded as a sequence of B10 commands.
- When the setting sequence has been completed, disable command logging by pressing the F2 key again ("**logging off**" displayed at bottom right).
- Call up the B10 program by pressing F3. Upon pressing F8 (LISTe), a list of commands is displayed - for the time being without comments - which has been generated by means of B10 commands and correspond to the settings just performed (in the example **Settings for a frequency sweep**).

```
10 UPL OUT "*RST"
20 UPL OUT "DISP:MODE COLB"
30 UPL OUT "SENS:VOLT:APER:MODE AFAS"
40 UPL OUT "SENS:FILT:AWE ON"
50 UPL OUT "DISP:TRAC:OPER CURV"
60 UPL OUT "DISP:TRAC:X:SPAC LOG"
70 UPL OUT "SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1"
```

Listing of B10 commands without comments. Comments will we added manually later on.

- Use command ASAVE "A:LOGGING.TXT" to store the listing as ASCII file on a floppy disk.
- Return to the UPL operating level by pressing F3 and quit the UPL (CTRL+F9).
- Using an editor of your own choice at the DOS operating system level, edit the A:LOGGING.TXT file in a form suitable for IEC/IEEE-bus control by replacing |**UPL OUT**| by |**IEC OUT 20,**| and store it on the floppy disk.

```
10 IEC OUT 20,"*RST"
20 IEC OUT 20,"DISP:MODE COLB"
30 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS"
40 IEC OUT 20,"SENS:FILT:AWE ON"
50 IEC OUT 20,"DISP:TRAC:OPER CURV"
60 IEC OUT 20,"DISP:TRAC:X:SPAC LOG"
70 IEC OUT 20,"SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1"
```

Listing of IEC/IEEE-bus commands without comments. Comments will be added manually later on!

- Establish connection to IEC/IEEE-bus controller and start R&S BASIC on the controller.
- Insert floppy holding the "LOGGING.TXT" file into the controller.
- Load the listing as ASCII file from the floppy with command ALOAD "A:LOGGING.TXT" and extend it as required by IEC/IEEE-bus-specific commands and comments.

```
10 IEC TERM 10:'              Controller waits for Line Feed as terminator
20 IEC TIME 10000:'                          IEC/IEEE-bus timeout 10 s
30 IEC OUT 20,"*RST;*WAI":'                          UPL default setup
40 IEC OUT 20,"DISP:MODE COLB":'                     Changes of colour
50 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS":'       High measurement speed
60 IEC OUT 20,"SENS:FILT:AWE ON":'          Switches on A-weighting filter
70 IEC OUT 20,"DISP:TRAC:OPER CURV":'              Selects trace display
80 IEC OUT 20,"DISP:TRAC:X:SPAC LOG":'                Logarithmic X axis
0 IEC OUT 20,"SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1":'      Autom. Sweep
100 IEC OUT 20,"DISP:CONF AP":'                    Selects graphic window
110 IEC OUT 20,"INIT:CONT OFF;*WAI":'     Starts sweep and waits for end
120 IEC OUT 20,"DISP:TRAC:Y:AUTO ONCE":'                      Autoscaling
130 IEC LAD 20: IEC GTL:'                    Return to manual control
140 END
```

(listing of IEC/IEEE-bus commands with additional commands and comments)

- Start the ready-to-run program with RUN or F2.

3.15.4 Initialization and Default Status

The controller must be informed that the end character for query replies from the UPL is < Line Feed> and that it has to wait for max. 10 s after a trigger command or an IEC-IN command before it signals a timeout. The IEC/IEEE-bus Status Registers and the UPL are reset to the default state.
For default settings of UPL see annex A UPL Default Setup

```
10 'Initialization of controller
10 IEC TERM 10:'                Controller waits for Line Feed as terminator
20 IEC TIME 10000:'       After 10 s controller signals IEC/IEEE-bus timeout
10 'Initialization of UPL
20 IECOUT 20,"*CLS":'                                  Resets Status Register
30 IECOUT 20,"*RST:*WAI":'    Resets device and waits for end of calibration
     :
```

3.15.5 Sending Instrument Setting Commands

In this routine, the UPL is set to maximum speed for triggered measurements.

```
10 IEC TERM 10:'                   Terminator for query replies is Line Feed
20 IEC TIME 10000:'              Max. waiting time for query replies is 10 s
30 IEC OUT 20,"*CLS":'                    Resets IEC/IEEE-bus Status Register
40 IEC OUT 20,"*RST;*WAI":'      UPL default setting, *WAI waits for calibr.
50 IEC OUT 20,"DISP:ANN OFF":'                    Switches off result display
60 IEC OUT 20,"SENS2:FUNC 'OFF'":'       Switches off input-peak measurement
70 IEC OUT 20,"SENS3:FUNC 'OFF'":'        Switches off frequency measurement
80 IEC OUT 20,"SENS:VOLT:APER:MODE VAL"
90 IEC OUT 20,"SENS:VOLT:APER 1ms":'        Sets a measurement speed of 1 ms
     :
```

3.15.6 Switchover to Manual Control

```
REM ------ Switching the instrument to manual control -------
     :
100 IEC LAD 20:'  Addresses UPL
110 IEC GTL:'     Sets UPL to local
     :
```

3.15.7 Readout of Instrument Settings

The settings made in section 3.15.5 Sending Instrument Setting Commands, are read out. In this case the short form of the commands is used.

```
     :
110 '------- Readout of instrument settings ---------
120 IEC OUT 20,"DISP:ANN?":'            Query for setting the display Update
130 IEC IN 20,A$: PRINT A$:'                                Displays OFF
140 IEC OUT 20,"SENS2:FUNC?":'              Query for input peak measurement
150 IEC IN 20,A$: PRINT A$:'                                Displays OFF
160 IEC OUT 20,"SENS:VOLT:APER?":'               Query for measurement speed
170 IEC IN 20,A$: PRINT A$:'                              Displays 1.E-3
     :
```

3.15.8 Readout of Measurement Results

Numeric results of a specific measurement function, ie input peak, input RMS or frequency and phase measurements, can be taken from the UPL in a triggered or non-triggered form.

For triggering measurements and sweeps see section 3.6.7 Triggering a Measurement/Sweep
Waiting for the end of a measurement or sweep is described in section 3.6.8.2 Wait for End of Measurement/Sweep.

The display below gives the IEC/IEEE-bus commands used for selecting and calling up measurement results.

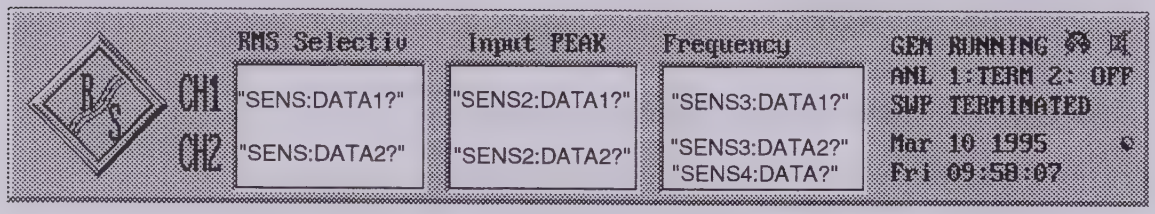


Fig. 3-8 Result display and associated IEC/IEEE-bus commands

Table 3-13 Selecting measurement results

Measurement function	Channel setting	Selection and readout of measurement results
Function	IECOUT 20,"INP:SEL CH1"	IECOUT 20,"SENS:DATA1?":IECIN 20,Func$
IECOUT 20, "SENS:FUNC 'RMS'"	IECOUT 20,"INP:SEL CH2"	IECOUT 20,"SENS:DATA2?":IECIN 20,Func$
"SENS:FUNC 'RMSS'" "SENS:FUNC 'PEAK'" "SENS:FUNC 'QPE'" "SENS:FUNC 'DC'" "SENS:FUNC 'THD'" "SENS:FUNC 'THDN'" "SENS:FUNC 'MDIST'" "SENS:FUNC 'DFD'" "SENS:FUNC 'DIM'" "SENS:FUNC 'WAF'" "SENS:FUNC 'POL'" "SENS:FUNC 'FFT'" "SENS:FUNC 'FILT'" "SENS:FUNC 'WAV'" "SENS:FUNC 'COHE'"	IECOUT 20,"INP:SEL CH1A" or IECOUT 20,"INP:SEL CH1I" or IECOUT 20,"INP:SEL CH2I" or IECOUT 20,"INP.SEL BOTH"	IECOUT 20,"SENS:DATA1?":IECIN 20,FuncA$ IECOUT 20,"SENS:DATA2?":IECIN 20,FuncB$
Input PEAK or Input RMS	IECOUT 20,"INP:SEL CH1"	IECOUT 20,"SENS2:DATA1?":IECIN 20,Ip$
IECOUT 20,	IECOUT 20,"INP:SEL CH2"	IECOUT 20,"SENS2:DATA2?":IECIN 20,Ip$
"SENS2:FUNC 'PEAK'" "SENS2:FUNC 'RMS'"	IECOUT 20,"INP:SEL CH1A" or IECOUT 20,"INP:SEL CH1I" or IECOUT 20,"INP:SEL CH2I" or IECOUT 20,"INP.SEL BOTH"	IECOUT 20,"SENS2:DATA1?":IECIN 20,IpA$ IECOUT 20,"SENS2:DATA2?":IECIN 20,IpB$
Frequency measurement	IECOUT 20,"INP:SEL CH1"	IECOUT 20,"SENS3:DATA1?":IECIN 20,Freq$
IECOUT 20,	IECOUT 20,"INP:SEL CH2"	IECOUT 20,"SENS3:DATA2?":IECIN 20,Freq$
"SENS3:FUNC 'FREQ'"	IECOUT 20,"INP:SEL CH1A" or IECOUT 20,"INP:SEL CH1I" or IECOUT 20,"INP:SEL CH2I" or IECOUT 20,"INP.SEL BOTH"	IECOUT 20,"SENS3:DATA1?":IECIN 20,FreqA$ IECOUT 20,"SENS3:DATA2?":IECIN 20,FreqB$

Measurement function	Channel setting	Selection and readout of measurement results
Frequency and phase measurement IECOUT 20, "SENS3:FUNC 'FQPH'" with two-channel measurements only	IECOUT 20,"INP:SEL CH1A" or IECOUT 20,"INP:SEL CH1I" or IECOUT 20,"INP:SEL CH2I" or IECOUT 20,"INP.SEL BOTH"	IECOUT 20,"SENS3:DATA1?":IECIN 20,Freq$ IECOUT 20,"SENS4:DATA?":IECIN 20,Phas$
Frequency and group delay measurement IECOUT 20, "SENS3:FUNC 'FQGR'" with two-channel measurements only	IECOUT 20,"INP:SEL CH1A" oder IECOUT 20,"INP:SEL CH1I" oder IECOUT 20,"INP:SEL CH2I" oder IECOUT 20,"INP.SEL BOTH"	IECOUT 20,"SENS3:DATA1?":IECIN 20,**Freq$** IECOUT 20,"SENS4:DATA?":IECIN 20,**Grpl$**

3.15.8.1 Readout of Triggered Measurements

Readout of triggered measurement is demonstrated by way of an RMS measurement:

```
    :
100 IEC OUT 20,"SENS:FUNC 'RMS'":'                    Sets RMS measurement
110 IEC OUT 20,"INPUT:SELECT CH1":'                        Sets channel 1
      :
210 'One of three trigger modes can be selected
220 INPUT "Select trigger mode INIT [I], GET [G] or *TRG [T]:";Tg$
      :
330 IEC OUT 20,"INIT:CONT OFF;*WAI":'        Selects single-measurement mode
      :
480 IF Tg$="I" THEN IEC OUT 20,"INIT":   GOTO In
490 IF Tg$="G" THEN IEC LAD 20: IEC GET :GOTO In
500 IF Tg$="T" THEN IEC OUT 20,"*TRG":   GOTO In
      :
620In:
630 IEC OUT 20,"*WAI":'           Sends next IEC/IEEE-bus command only after
640 '                                        a result has been obtained.
650 IEC OUT 20,"SENS:DATA1?":'               Selects result of channel 1
660 IEC IN 20,Mwert$:'                       Reads in measurement result
667 PRINT Mwert$:'                            Outputs measurement result
      :
```

3.15.8.2 Readout of Non-Triggered Measurements

Contrary to triggered measurements, results of non-triggered measurements are read from the buffer at maximum speed without considering settling so that the same value is displayed several times before a new value is output.
Since results of non-triggered measurements are read out as an exception, no detailed description will be given. Reading out triggered measurement results as described in section 3.15.8.1 Readout of Triggered Measurements, is to be preferred in any case.

```
    :
190 IEC OUT 20,"*RST;*WAI": '                          Sets up RMS measurement
200 IEC OUT 20,"DISP:ANN OFF":'                    Switches off result display
210 IEC OUT 20,"SENS2:FUNC 'OFF'":'             Switches off PEAK measurement
220 IEC OUT 20,"SENS3:FUNC 'OFF'":'        Switches off frequency measurement
230 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS":'   Selects high measurement speed
240 IEC OUT 20,"INIT:CONT ON":'              Selects continuous measurements
250 IEC LAD 20: IEC GET :'             Triggers with Group Executive Trigger
260 '"*WAI" omitted!
270 IEC OUT 20,"SENS:DATA1?":'                Selects RMS result on channel 1
280 IEC IN 20,Mwert$:'                           Reads in measurement result
    :
```

3.15.9 Sweep Setting/Trigger

3.15.9.1 Generator Sweep

With a generator sweep of the UPL, output frequency, output level, burst duration, etc. are swept between the start/stop values .
A sweep is triggered with `INIT`, `*TRG` or `GET` (see section 3.6.7 Triggering a Measurement/Sweep).

```
    :
50 IEC OUT 20,"SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1":'        Freq. sweep
60 IEC OUT 20,"SOUR:FREQ:STAR 100 HZ":'          Sweep start frequency 100 Hz
70 IEC OUT 20,"SOUR:FREQ:STOP 10 KHZ":'          Sweep stop frequency 10 kHz
80 IEC OUT 20,"SOUR:SWE:FREQ:POIN 15":'                      15 sweep points
90 IEC OUT 20,"SENS:FILT:AWE ON": '               Selects A-weighting filter
100 IEC OUT 20,"DISP:TRAC:OPER CURV": '                Selects trace display
110 IEC OUT 20,"INIT:CONT OFF;*WAI":'   Triggers single sweep, waits for end
120 IEC OUT 20,"DISP:CONF AP":' Selects analyzer display with graphic window
130 IEC LAD 20: IEC GTL: '                              Displays sweep curve
    :
```

See also section 3.15.10.3 Configuration for Maximum Sweep Speed and 3.15.10.3.1 Generator Sweep.

3.15.9.2 External Sweep

With external sweep of UPL, measurement results are obtained by frequency and level variations at channel 1 or 2 of the analyzer input.
The example below illustrates an external frequency sweep.

```
    :
300 '*** Setting parameters for external sweep
310 IEC OUT 20,"TRIG:SOUR CH1F": '        Setup for external frequency sweep
320 IEC OUT 20,"ARM:LEV:MIN 100 mV": '                Minimum level 100 mV
330 IEC OUT 20,"ARM:FREQ:STAR 100 Hz": '             Start frequency 100 Hz
340 IEC OUT 20,"ARM:FREQ:STOP 16 kHz": '              Stop frequency 16 kHz
350 IEC OUT 20,"TRIG:FREQ:VAR 4.5": '       Var. just below sweep step width
360 IEC OUT 20,"DISP:CONF AP": '                      Selects graphic window
370 PRINT "External sweep is started - recording is in progress!"
380 IEC OUT 20,"INIT:CONT OFF;*WAI": '        Triggers external single sweep
390 IEC OUT 20,"SYST:BEEP:STAT ON": ' Waits for sweep end with dummy command
400 IEC LAD 20: IEC GTL : '                                   Displays curve
    :
```

See also section 3.15.10.3 Configuration for Maximum Sweep Speed and 3.15.10.3.2 External Sweep.

3.15.9.3 RMS-Selektiv-Sweep

With the RMS selective sweep, the center frequency of a bandpass or bandstop filter is swept between the start/stop frequencies and an RMS measurement is carried out after each sweep step.
The sweep is triggered with "INIT", "*TRG" or GET (see section 3.6.7 Triggering a Measurement/Sweep)

```
    :
100 IEC OUT 20,"SENS:FUNC 'RMSS':'      Setup for RMS selective measurement
110 IEC OUT 20,"SENS:BAND:MODE PPCT1":'      Bandwidth of bandpass filter 1%
120 IEC OUT 20,"SENS:FREQ:MODE SWE;:SENS:SWE:MODE AUTO":'        Sweep setup
130 IEC OUT 20,"SENS:SWE:SPAC LOG;POIN 50":'       Log. sweep with 50 points
140 IEC OUT 20,"SENS:FREQ:STAR 4000Hz;STOP 16000Hz":'       Start/stop freq.
150 IEC OUT 20,"INIT:CONT OFF;*WAI":'       Triggers sweep and waits for end
160 IEC OUT 20,"DISP:TRAC:OPER CURV":'                 Selects trace display
170 IEC OUT 20,"DISP:CONF AP":'   Selects analyzer panel with graphic window
180 IEC LAD 20: IEC GTL:'                                     Displays curve
    :
```

See also section 3.15.10.3 Configuration for Maximum Sweep Speed and 3.15.10.3.3 RMS-selective Sweep.

3.15.10 Tuning - Setup for Maximum Measurement Speed

3.15.10.1 Configuration for Maximum Measurement Speed

To obtain maximum measurement speed, all unnecessary measurements and result displays are to be avoided. This is demonstrated by way of a fast RMS measurement:

```
    :
190 IEC OUT 20,"*RST;*WAI": '                          Sets up RMS measurement
200 IEC OUT 20,"DISP:ANN OFF":'                      Switches off result display
210 IEC OUT 20,"SENS2:FUNC 'OFF'":'                Switches off PEAK measurement
220 IEC OUT 20,"SENS3:FUNC 'OFF'":'             Switches off frequency measurement
230 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS":'     Selects high measurement speed
240 IEC OUT 20,"INIT:CONT OFF":'                     Selects single measurement
250 IEC LAD 20: IEC GET :'           Triggers sweep with Group Execute Trigger
260 IEC OUT 20,"*WAI":' *WAI                       Waits for measurement results
270 IEC OUT 20,"SENS:DATA1?":'                   Selects RMS results on channel 1
280 IEC IN 20,Mwert$:'                                  Reads in measured value
    :
```

3.15.10.2 Adapting Measurement Speed to Signal Frequency

Table 3-14 Hints for matching measurement speed and signal frequency

Automatic adaptation of measurement speed to signal frequency	
IEC/IEEE-bus command	**Used for**
"SENSe[1]:VOLTage:APERture:MODE AFASt"	RMS and RMS selective measurements: Automatic matching of measurement time and signal frequency by taking into account the signal period. The measurement time is optimally adapted to the input signal. An algorithmic error of max. 1% may occur
"SENSe[1]:VOLTage:APERture:MODE AUTO"	RMS and RMS selective measurements: Same as AFASt but with an algorithmic error of max. 0.1%.

Fixed measurement speed	
IEC/IEEE-bus command	**Used for**
`"SENSe[1]:VOLTage:APERture:MODE SFASt"`	RMS and RMS selective measurements: measurement time 50 ms
`"SENSe[1]:VOLTage:APERture:MODE FAST"`	RMS, RMS selective and DC measurements: measurement time 200 ms
`"SENSe[1]:VOLTage:APERture:MODE SLOW"`	RMS and RMS selective measurements: measurement time 1000 ms
`"SENSe[1]:VOLTage:APERture:MODE VALue"` `"SENSe[1]:VOLTage:APERture xxx ms"`	RMS-, RMS selective and DC measurements: measurement time freely selectable

VALue is a **fixed integration time** irrespective of the signal period.

RMS and RMS selective measurements:

- If the measurement time is an integral multiple of the signal period, optimum integration and therefore a steady display is obtained.
- If the measurement time is longer and not an integral multiple of the signal period, an integration is obtained with a beat effect in the display.

DC measurements:

If an AC voltage is superimposed on the DC, the measurement time as integration period has different effects with respect to the signal period of the AC voltage shows different effects:

- If the measurement time is an integral multiple of the signal period, optimum integration is obtained. The AC voltage does not influence the DC measurement result and the display is steady.
- If the measurement time is longer and not an integral multiple of the signal period, an integration is obtained with a beat effect in the display. The AC voltage has no effect on the DC measurement result.
- If the measurement time is shorter than the signal period, the measurement result follows the signal curve. The AC voltage affects the DC measurement result.

Fixed monitor time	
IEC/IEEE-bus command	**Used for**
`"SENSe[1]:VOLTage:INTVtime:MODE SFASt"`	PEAK measurements: time 50 ms
`"SENSe[1]:VOLTage:INTVtime:MODE FAST"`	PEAK measurements: time 200 ms
`"SENSe[1]:VOLTage:INTVtime:MODE SLOW"`	PEAK measurements: time 1000 ms
`"SENSe[1]:VOLTage:INTVtime:MODE FIXed"`	QPK measurements: time 3000 ms
`"SENSe[1]:VOLTage:INTVtime:MODE VALue"` `"SENSe[1]:VOLTage:INTVtime xxx ms"`	PEAK and QPK measurements: time freely selectable Generally no recommendation can be made as to the most suitable monitor time for peak values, as it depends on the input signal and on the measurement itself.

3.15.10.3 Configuration for Maximum Sweep Speed

3.15.10.3.1 Generator Sweep

To obtain maximum sweep speed, switch off all "slowing-down" settings. Particularly the frequency measurement and settling of the low-distortion generator are very time-consuming. If permitted by the measurement, these functions should be switched off.

The following example illustrates which functions are to be switched on or off to obtain maximum sweep speed.
A typical example is a

- **single-channel linear frequency sweep** on channel 1 of
- **100 points,**
- **200 Hz to 4 kHz** and
- **RMS measurement** in
- **AUTO FAST**.

Each speed-reducing function can be switched off separately by means of a command after the *RST command. In this case a single sweep should be triggered once with "INIT:CONT OFF;*WAI" (program line 230) before sweeping is started to avoid the setting times of this command influencing the sweep time. The sweep performed at maximum speed is then triggered with another INIT command (program line 300).

```
 :
100   IEC OUT 20,"*RST;*WAI"
110   IEC OUT 20,"INP:TYPE GEN1"
120   IEC OUT 20,"OUTP:SEL CH2"
130   IEC OUT 20,"SENS:VOLT:RANG 1V": '                    Prevent ranging
140   IEC OUT 20,"SOUR:LOWD OFF": '              Low-distortion generator off
150   IEC OUT 20,"SENS:VOLT:APER:MODE GENT": '    Measurement speed GEN TRACK
160   IEC OUT 20,"SENS2:FUNC 'OFF'": '             Input peak measurement off
170   IEC OUT 20,"SENS3:FUNC 'OFF'": '             Frequency measurement off
180   IEC OUT 20,"DISP:ANN OFF": '               No display of measured values
190   IEC OUT 20,"SOUR:SWE:MODE AUTO;:SOUR:FREQ:MODE SWE1": 'Frequency sweep
200   IEC OUT 20,"SOUR:FREQ:STAR 200;STOP 4000": '      Sweep 200Hz to 4kHz
210   IEC OUT 20,"SOUR:SWE:FREQ:SPAC LIN": '                   Linear sweep
220   IEC OUT 20,"SOUR:SWE:FREQ:POIN 100": '               100 Sweep points
230   IEC OUT 20,"INIT:CONT OFF;*WAI": '                 Triggers single sweep
240   IEC OUT 20,"SYST:BEEP:STAT OFF": '     Dummy command waits for sweep end
 :
300 IEC OUT 20,"INIT;*WAI": ' Einzelswp mit max. Geschwindigkeit ausloesen
310 IEC OUT 20,"SYST:BEEP:STAT OFF": ' Dummy command waits for sweep end
 :
```

The fastest way to set a suitable sweep is to load an ACTUAL SETUP in which the required settings have already been made.

```
 :
100 IEC OUT 20,"MMEM:LOAD:STAT 0,'C:\UPL\USER\MAXSWP.SAC';*WAI"
110 IEC OUT 20,"INIT;*WAI": '                        Triggers single sweep
120 IEC OUT 20,"SYST:BEEP:STAT OFF": '     Dummy command waits for sweep end
 :
```

The maximum sweep speed attained in this example is approx. 25 ms/step when an UPL with 386 board is used and approx. 8 ms/step when a 486 board is used.

3.15.10.3.2 External Sweep

The example below demonstrates the setup for a fast external frequency sweep with a sweep-signal sequence obtained, for instance, from a CD or tape.

Matching the external frequency sweep to the signal sequence:

- Set a start value which should corresponds to the expected lowest frequency of the sweep-signal sequence.
- Select a stop value slightly below the expected highest sequence frequency (approx. 0.1%) to provide a safe halt criterion.
- elect a variation that is approx. 5 to 10 % lower than the expected frequency variation of the signal sequence to ensure safe triggering and avoid unwanted intermediate values.

The example below illustrates the settings for matching the external sweep of the UPL to the signal sequence generated by a sweep generator for demonstration purposes.
Connect the sweep generator to UPL input UNBAL Ch1, and set and start a

- continuous logarithmic sweep of 100 Hz to 16.1 kHz,
- with a step width 5%,
- and 120-ms time tick

The external sweep parameters of the UPL are set as recommended above and the external single sweep is started.

- Start frequency of ext. sweep = 100 Hz (expected lowest frequency in this case 100 Hz)
- Stop frequency of ext. sweep = 16 kHz (0.1% below the expected highest frequency, in this case 16.1 kHz)
- Variation of ext. sweep = 4.5% (10% below the expected frequency variation of the sequence, in this case 5 %)

Each time the frequency varies by more than 4.5% on channel 1, UPL carries out an RMS measurement until a frequency greater than 16 kHz is measured. After this the external sweep is terminated and the sweep curve is displayed.

With the speed-increasing settings in lines 270 to 290 and the fast frequency measurement for the external sweep in line 310, a signal sequence with a **minimum time tick of 120 ms** can still be reliably measured. For all other settings a longer time is required.

```
    :
260 '*** Speed-increasing settings
270 IEC OUT 20,"DISP:ANN OFF": '                          Display Update off
280 IEC OUT 20,"SENS3:FUNC 'OFF'": '                  Frequency measurement off
290 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS": '       RMS meas. speed AUTO FAST
300 '*** Setting of external sweep parameters
310 IEC OUT 20,"TRIG:SOUR CH1R": '    Ext. sweep with fast freq. measurement
320 IEC OUT 20,"ARM:LEV:MIN 100 mV": '              Measurement above 100 mV
330 IEC OUT 20,"ARM:FREQ:STAR 100 Hz": '              Start frequency 100 Hz
340 IEC OUT 20,"ARM:FREQ:STOP 16 kHz": '               Stop frequency 16 kHz
350 IEC OUT 20,"TRIG:FREQ:VAR 4.5": '       Var. just below sweep step width
360 IEC OUT 20,"DISP:CONF AP": '                       Selects graphic window
370 PRINT "External sweep is started - recording goes on!"
380 IEC OUT 20,"INIT:CONT OFF;*WAI": '        Triggers external single sweep
390 IEC OUT 20,"SYST:BEEP:STAT ON": '      Dummy command waits for sweep end
400 IEC LAD 20: IEC GTL : '                                  Displays curve
    :
```

3.15.10.3.3 RMS Selective Sweep

In the example below settings are made for a fast RMS selective sweep. The sweep speed mainly depends on the

- bandwidth of the set bandpass /bandstop filter and the
- center frequency.

The bandpass or bandstop filters are very steep filters with an attenuation of 100 dB. The higher the center frequency the wider the passband range and the faster the settling and therefore the RMS selective measurement.
The example below illustrates a fast RMS selective sweep of a 5-kHz squarewave signal produced by the UPL generator. The narrowband RMS measurement from 4 to 16 kHz yields a spectrum display of the fundamental with the 2nd and 3rd harmonic of the squarewave signal.

```
10 IEC TERM 10: IEC TIME 60000
20 IEC OUT 20,"*RST;*WAI;:DISP:MODE COLB;:INP:TYPE GEN2"
30 IEC OUT 20,"SOUR:FUNC SQU;:SOUR:FREQ 5000Hz;:SOUR:VOLT 1V"
70 IEC OUT 20,"SENS:FUNC 'RMSS'":'     Switches on RMS selective measurement
80 '*** Speed-increasing measures
90 IEC OUT 20,"SENS:VOLT:APER:MODE AFAS":'              Fast RMS measurement
100 IEC OUT 20,"SENS2:FUNC 'OFF'":'                Input-peak measurement off
110 IEC OUT 20,"SENS3:FUNC 'OFF'":'                 Frequency measurement off
120 IEC OUT 20,"DISP:ANN OFF":'                        Display Update off
130 '*** Settings for RMS selective sweep
140 IEC OUT 20,"SENS:BAND:MODE PPCT1":'                  Bandpass filter 1%
150 IEC OUT 20,"SENS:FREQ:MODE SWE;:SENS:SWE:MODE AUTO":'         Auto sweep
160 IEC OUT 20,"SENS:SWE:SPAC LOG;POIN 50":'       Log. sweep over 50 points
180 IEC OUT 20,"SENS:FREQ:STAR 4000Hz;STOP 16000Hz":'   Start/stop frequency
190 '*** Settings for graphics display
200 IEC OUT 20,"DISP:TRAC:OPER CURV"
210 IEC OUT 20,"DISP:TRAC:Y:UNIT DBV;:DISP:TRAC:X:AUTO OFF"
220 IEC OUT 20,"DISP:TRAC:X:LEFT 3000Hz;RIGH 17000Hz":'                X scale
230'Measuring the sweep time
240 Z1=TIME
250 IEC OUT 20,"INIT:CONT OFF;*WAI"
260 IEC OUT 20,"DISP:CONF AP":'   Selects analyzer panel with graphic window
270 Z2=TIME: IEC LAD 20: IEC GTL:'                          Displays spectrum
280 PRINT (Z2-Z1)/100;" Sec pro Sweep": END
```

Speed-increasing measures become more effective towards higher center frequencies (> 5 kHz)!

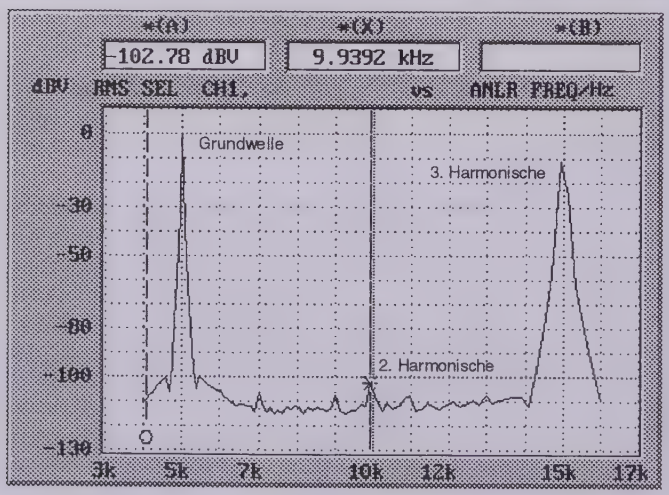


Fig. 3-9 Spectrum of 5-kHz squarewave obtained through RMS selective sweep

3.15.11 List Management

3.15.11.1 Loading Lists into the UPL

3.15.11.1.1 Loading Sweep Lists into the UPL

Depending on the application, data are loaded into the UPL by a variety of commands that can be looked up in section 3.10.6 Commands for Graphical Representation of Results. Loading the frequency values for a frequency sweep is used as an example for demonstrating the procedure.
Load command:
"SOURce:LIST:FREQuency 100.0,300.0,500.0, ... ,20000"
permits a maximum of 1024 values to be loaded.

Use DATA and READ for handling a greater number of frequency values in program code:

```
    :
8110 DATA 100,300,500,700,800,900,1000,2000,3000,4000,5000,6000,7000
8120 DATA 10000,13000,15000,17000,20000,0
8150 IEC OUT 20,"SOUR:SWE:MODE AUTO":'                          AUTO sweep
8160 IEC OUT 20,"SOUR:FREQ:MODE LIST1":'          LIST sweep of frequencies
8170 Bef$="SOUR:LIST:FREQ": '               Lists block data of frequencies
8180 READ Frq
8190 Loop1:
8200 IF Frq<>0 THEN Bef$=Bef$+STR$(Frq)
8210 READ Frq: IF Frq<>0 THEN Bef$=Bef$+",": GOTO Loop1
8230 IEC OUT 20,Bef$:'                                Outputs block command
    :
```

3.15.11.1.2 Loading and Display of Several Traces in the UPL

Not only curves generated in the UPL by a sweep or FFT, or those stored in a file can be graphically displayed but also any data sequences loaded into the UPL by the control program. All UPL capabilities for scaling and unit conversion are used for the graphic display.
The following routine demonstrates loading of three traces into the UPL and their graphic display.

```
    :
200 '************************ Loading traces ****************************
210 IEC OUT 20,"DISP:TRAC:COUN 3":'       Sets number of traces to be loaded
220 IEC OUT 20,"DISP:TRAC:IND 0":'                Selects trace with index 0
230 IEC OUT 20,"TRAC LIST1, 100,1000,5000,15000":'      X values for trace 0
240 IEC OUT 20,"TRAC TRAC1, 0.001,0.01,0.01,0.001":    'Y values for trace 0
250 IEC OUT 20,"DISP:TRAC:IND 1":'                Selects trace with index 1
260 IEC OUT 20,"TRAC LIST1, 100,1500,5500,15000":'      X values for trace 1
270 IEC OUT 20,"TRAC TRAC1, 0.001,0.02,0.02,0.001":    'Y values for trace 1
280 IEC OUT 20,"DISP:TRAC:IND 2":'                Selects trace with index 2
290 IEC OUT 20,"TRAC LIST1, 100,1800,6000,15200":'      X values for trace 2
300 IEC OUT 20,"TRAC TRAC1, 0.001,0.03,0.03,0.001":    'Y values for trace 2
310 IEC OUT 20,"DISP:TRAC:OPER CURV":'              Selects the display mode
320 IEC OUT 20,"DISP:TRAC:Y:AUTO ONCE":'                  Optimizes scale
330 IEC OUT 20,"DISP:CONF AP":'    Activates analyzer panel + graphic window
340 IEC LAD 20:IEC GTL:'                                  Displays curve
    :
```

Note:

If traces are loaded into the UPL under program control and a sweep is subsequently selected, the trace in the display will be erased and the sweep curve displayed.

3.15.11.1.3 Loading and Displaying of Trace Pairs in the UPL

The program below demonstrates loading of three trace pairs into the UPL, the graphic display, subsequent selection of another unit, rescaling and changing from linear to logarithmic display on the X axis.

```
    :
290 IEC OUT 20,"DISP:TRAC1:FEED 'SENS:DATA'":'                Enables trace A
300 IEC OUT 20,"DISP:TRAC2:FEED 'SENS:DATA'":'                Enables trace B
310 IEC OUT 20,"DISP:TRAC:COUN 3":'Three trace pairs
320 IEC OUT 20,"DISP:TRAC:IND 0":'          Selects trace pair with index 0
330 IEC OUT 20,"TRAC LIST1, 100,1000,5000,15000":'       X values of trace A
340 IEC OUT 20,"TRAC TRAC1, 0.001,0.01,0.01,0.001":'     Y values of trace A
350 IEC OUT 20,"TRAC LIST2, 100,1100,5100,15000":'       X values of trace B
360 IEC OUT 20,"TRAC TRAC2, 0.001,0.02,0.02,0.001":'     Y values of trace B
370 IEC OUT 20,"DISP:TRAc:IND 1":'          Selects trace pair with index 1
380 IEC OUT 20,"TRAC LIST1, 100,1500,5500,15000":'       X values of trace A
390 IEC OUT 20,"TRAC TRAC1, 0.001,0.03,0.03,0.001":'     Y values of trace A
400 IEC OUT 20,"TRAC LIST2, 100,1600,5600,15000":'       X values of trace B
410 IEC OUT 20,"TRAC TRAC2, 0.001,0.04,0.04,0.001":'     Y values of trace B
420 IEC OUT 20,"DISP:TRAc:IND 2":'          Selects trace pair with index 2
430 IEC OUT 20,"TRAC LIST1, 100,1800,6000,15200":'       X values of trace A
440 IEC OUT 20,"TRAC TRAC1, 0.001,0.05,0.05,0.001":'     Y values of trace A
450 IEC OUT 20,"TRAC LIST2, 100,1900,6100,15200":'       X values of trace B
460 IEC OUT 20,"TRAC TRAC2, 0.001,0.06,0.06,0.001":'     Y values of trace B
470 IEC OUT 20,"DISP:TRAC:OPER CURV":'                 Selects trace display
480 IEC OUT 20,"DISP:TRAC2:Y:EQU ON":'      Scaling of trace B same as for A
490 IEC OUT 20,"DISP:TRAC1:Y:AUTO ONCE":'                    Autoscaling
500 IEC OUT 20,"DISP:CONF DP":'    Selects DISPLAY panel with graphic window
510 IEC LAD 20: IEC GTL: HOLD 5000:'                Result display for 5 s
520 IEC OUT 20,"DISP:TRAC1:Y:UNIT W":'     Conversion of Y values into Watt
530 IEC OUT 20,"DISP:TRAC1:Y:AUTO ONCE":'                    Autoscaling
540 IEC LAD 20: IEC GTL:HOLD 5000:'                 Result display for 5 s
550 IEC OUT 20,"DISP:TRAC:X:SPAC LOG":'                Log display on X scale
560 IEC OUT 20,"DISP:TRAC1:Y:AUTO ONCE":'                    Autoscaling
570 IEC LAD 20: IEC GTL
    :
```

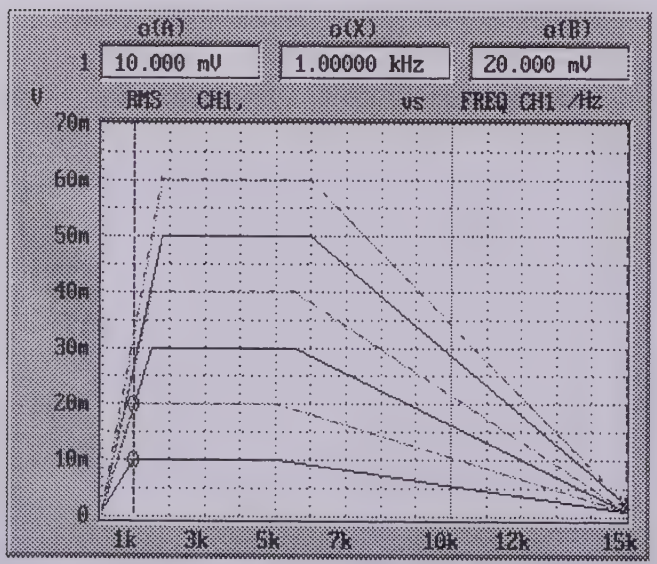


Fig. 3-10 Trace pairs loaded into UPL by control program

3.15.11.2 Readout of Data Lists from the UPL

When data lists are read from the UPL, in compliance with SCPI values are always transferred in the basic unit even if other units have been selected for the trace display. The table below shows the basic units for transferring data of various functions from the UPL to the controller.

Table 3-15 Basic units of data

Measurement function/sweep settings	Data with basic unit for analog/digital instruments
"SENS:FUNC 'RMS'"	V/FS
"SENS:FUNC 'RMSS'"	V/FS
"SENS:FUNC 'PEAK'"	V/FS
"SENS:FUNC 'QPE'"	V/FS
"SENS:FUNC 'DC'"	V/FS
"SENS:FUNC 'THD'"	%
"SENS:FUNC 'THDN'" "SENS:FUNC:MMOD THDN|NOIS "SENS:FUNC:MMOD SNDR "SENS:FUNC:MMOD LTHD|LNOI	% % % (große Werte) V/FS
"SENS:FUNC 'DFD'"	%
"SENS:FUNC 'DIM'"	%
"SENS:FUNC 'MDIS'"	%
"SENS:FUNC 'WAF'"	%
"SENS:FUNC 'POL'"	keine Daten
"SENS:FUNC 'FFT'"	V/FS
"SENS:FUNC 'WAV'"	V/FS
"SENS:FUNC 'COHE'"	%
"SENS:FUNC 'RUBB'"	V
"SENS2:FUNC 'PEAK'"	V/FS
"SENS2:FUNC 'RMS'"	V/FS
"SENSe2:FUNCtion 'DIGInpamp'"	V
"SENSe2:FUNCtion 'PHASetoref'"	UI
"SENS3:FUNC 'FREQ'"	Hz
"SENS3:FUNC 'FQPH'"	Grad
"SENS3:FUNC 'FQGR'"	s
"SOUR:FREQ:MODE ..."	Hz
"SOUR:VOLT:MODE ..."	V/FS
"SOUR:ONT:MODE ..."	s
"SOUR:INT:MODE ..."	s
"SENS:FREQ:MODE ..."	Hz

When reading out lists remember that with commands
- "SOUR:LIST:FREQ?"
- "SOUR:LIST:INT?"
- "SOUR:LIST:ONT?"
- "SOUR:LIST:VOLT?"
- "SENS:LIST:FREQ?"

always the X values of the set sweep are read, contrary to commands
- "TRAC? LIST1"
- "TRAC? LIST2"

which cause the X values of the current graphic display to be read.

Note:

Normally, X values are identical for both command groups. They are only different if ***other than the sweep curve*** *is* ***subsequently*** *selected by means of program control or by loading a file while the sweep mode is on.*

3.15.11.2.1 Readout of Lists of up to 1024 Values

A great number of application-specific commands are available for reading out sweep data, FFT data, data loaded from a file or by the control program (see section 3.10.6 Commands for Graphical Representation of Results). The procedure is illustrated by an example for reading out level values of a frequency sweep.
The readout procedure is as follows

"TRAC? TRAC" permits 1024 values to be read.

```
      :
8270 IEC OUT 20,"INIT:CONT OFF;*WAI": '              Triggers a single sweep
      :
8420 IEC OUT 20,"TRAC? TRAC":'                  Reads in level data of trace A
8430 IEC IN 20,S$:'    S$ comprises an ASCII string with level values in the
8440 '                          form "1.1234E-003,2.3456E-002,3.4567E-001 ..."
      :
```

3.15.11.2.2 Readout of FFT Lists of more than 1024 Values

The number of values that can be transferred is limited to 1024 lines. If more than 1024 lines are to be read, the data have to be divided in blocks of 1024 values. The table in section 2.6.5.12 FFT informs on the number of lines of the selected FFT which are a function of FFT size and zooming.

In the R&S BASIC program below, the 7488 lines of a 8k-zoom FFT with 8 blocks each (7 x 1024 and 1 x 320 lines) are read and stored in the form of a string
(eg "5.50884e-004,4.1273e-004,1.64638e-004,...") in files FFT_Y1.TXT ... FFT_Y8.TXT.

```
      :
500 FOR Blkidx=0 TO 7
510  IEC OUT 20,"DISP:TRAC:IND"+STR$(Blkidx):'    Selects block index 0 to 7
520  '                       Reads out FFT lines and stores in string Fftdat$
530  IEC OUT 20,"TRAC? TRAC"
540  IEC IN 20,Fftdat$:'                      Reads in FFT data as ASCII string
550  Filename$="FFT_Y"+RIGHT$(STR$(Blkidx+1),1)+".TXT":'   Defines file name
560  OPENO# 1,Filename$: PRINT# 1,Fftdat$: CLOSE# 1
570 NEXT Blkidx
      :
```

FFT line frequencies are read out in the same way with command
"TRAC? LIST1"

3.15.11.2.3 FFT Lists with Suppressed Noise Floor

Since in most cases the noise floor of an FFT is of no interest, the number of lines can be considerably reduced by including only values exceeding a certain limit in the trace, eg 0.1 V.
To do so set the UPL as described below:

```
                :
100 IECOUT 20,"DISPlay:TRACe:OPERation FFTErrors":'          Sets limits
110 IECOUT 20,"CALCulate:LIMit:UPPer:VALue 0.1V":'..            >0.1 V
                :
510 IEC OUT 20,"DISP:TRAC:IND 0":'                          Block index 0
520 IEC OUT 20,"TRAC? TRAC":'                 Stores FFT lines above 0.1 V
530 IEC IN 20,Fftdat$:'                       as string data under Fftdat$
                :
```

FFT lines frequencies are read out in the same way using command
"TRAC? LIST1"

3.15.11.2.4 Readout of Several Traces from UPL

If several traces are displayed on the UPL (**"DISP:TRAC:COUN > 1"** set), the required trace can be selected with command **"DISP:TRAC:IND 0 to 17"** and read out with commands **"TRAC? LIST1"** and **"TRACE? TRAC"**:

```
    :
200 '***************** Readout of traces ********************
220 IEC OUT 20,"DISP:TRAC:IND 0":'                Selects trace with index 0
230 IEC OUT 20,"TRAC? LIST1":'        Selects X values of trace with index 0
240 IEC IN 20,X0$:'                 Stores X values as ASCII string under X0$
250 IEC OUT 20,"TRAC? TRAC":'         Selects Y values of trace with index 0
260 IEC IN 20,Y0$:'                  Stores Y values as ASCII string under Y0
270 IEC OUT 20,"DISP:TRAC:IND 1":'                Selects trace with index 1
280 IEC OUT 20,"TRAC? LIST1":'        Selects X values of trace with index 1
290 IEC IN 20,X1$:'                 Stores X values as ASCII string under X1$
300 IEC OUT 20,"TRAC? TRAC":'         Selects Y values of trace with index 1
310 IEC IN 20,Y1$:'                 Stores Y values as ASCII string under Y1$
320 IEC OUT 20,"DISP:TRAC:IND 2":'                Selects trace with index 2
330 IEC OUT 20,"TRAC? LIST1":'        Selects X values of trace with index 2
340 IEC IN 20,X2$:'                 Stores X values as ASCII string under X1$
350 IEC OUT 20,"TRAC? TRAC":'         Selects Y values of trace with index 2
    :
```

3.15.11.2.5 Readout of Trace Pairs from UPL

Trace pairs are read out in the way described in section 3.15.11.2.4 Readout of Several Traces from UPL, with the difference
"TRAC? LIST1" and "TRAC? TRAC1" reads out the X and Y values of trace A
"TRAC? LIST2" and "TRAC? TRAC2" reads out the X and Y values of trace B

```
     :
200 '******************** Readout of trace pairs**********************
220 IEC OUT 20,"DISP:TRAC:IND 0":'          Selects trace pair with index 0
230 IEC OUT 20,"TRAC? LIST1":'      Selects X values of trace A with index 0
240 IEC IN 20,Xa0$:'              Stores X values as ASCII string under Xa0$
250 IEC OUT 20,"TRAC? TRAC1":'      Selects Y values of trace A with index 0
260 IEC IN 20,Ya0$:'              Stores Y values as ASCII string under Ya0$
270 IEC OUT 20,"TRAC? LIST2":'      Selects X values of trace B with index 0
280 IEC IN 20,Xb0$:'              Stores X values as ASCII string under Xb0$
290 IEC OUT 20,"TRAC? TRAC2":'      Selects Y values of trace B with index 0
300 IEC IN 20,Yb0$:'              Stores Y values as ASCII string under Yb0$
310 '
320 IEC OUT 20,"DISP:TRAC:IND 1":'          Selects trace pair with index 1
330 IEC OUT 20,"TRAC? LIST1":'      Selects X values of trace A with index 1
340 IEC IN 20,Xa1$:'              Stores X values as ASCII string under Xa0$
350 IEC OUT 20,"TRAC? TRAC1":'      Selects Y values of trace A with index 1
360 IEC IN 20,Ya1$:'              Stores Y values as ASCII string under Ya0$
370 IEC OUT 20,"TRAC? LIST2":'      Selects X values of trace B with index 1
380 IEC IN 20,Xb1$:'              Stores X values as ASCII string under Xb0$
390 IEC OUT 20,"TRAC? TRAC2":'      Selects Y values of trace B with index 1
400 IEC IN 20,Yb1$:'              Stores Y values as ASCII string under Yb0$
410 '
420 IEC OUT 20,"DISP:TRAC:IND 2":'          Selects trace pair with index 2
430 IEC OUT 20,"TRAC? LIST1":'      Selects X values of trace A with index 2
440 IEC IN 20,Xa2$:'              Stores X values as ASCII string under Xa0$
450 IEC OUT 20,"TRAC? TRAC1":'      Selects Y values of trace A with index 2
460 IEC IN 20,Ya2$:'              Stores Y values as ASCII string under Xa0$
470 IEC OUT 20,"TRAC? LIST2":'      Selects X values of trace B with index 2
480 IEC IN 20,Xb2$:'              Stores X values as ASCII string under Xa0$
490 IEC OUT 20,"TRAC? TRAC2":'      Selects Y values of trace B with index 2
500 IEC IN 20,Yb2$:'              Stores Y values as ASCII string under Xa2$
     :
```

3.15.12 Filter Settings

In the case of RMS measurements, the analyzer permits a maximum of 4 filters to be switched into the measurement path, 3 filters with PEAK and QPK measurements and one filter with THDN measurements. Fixed filters like CCITT, CCIR or WRUMble or user-defined filters can be used.
The example below illustrates a customized filters made up of a bandpass filter of 11 to 15 kHz and the two notch filters of 12 and 14 kHz.

```
    :
300 IEC OUT 20,"*RST;*WAI": '              *WAI waits for end of calibration
310 IEC OUT 20,"DISP:MODE COLB":'                    Coloured user interface
315 '----- User filter No. 1: Bandpass filter 11 to 15 kHz, Atten. 100 dB
320 IEC OUT 20,"SENS:UFIL1:BPAS ON"
330 IEC OUT 20,"SENS:UFIL1:PASS:LOW 11 KHZ"
340 IEC OUT 20,"SENS:UFIL1:PASS:UPP 15 KHZ"
350 IEC OUT 20,"SENS:UFIL1:ATT 100 DB"
355 '----- User filter No. 2: 12-kHz notch filter
360 IEC OUT 20,"SENS:UFIL2:NOTC ON"
370 IEC OUT 20,"SENS:UFIL2:CENT 12 KHZ"
380 IEC OUT 20,"SENS:UFIL2:WIDT 500 HZ"
390 IEC OUT 20,"SENS:UFIL2:ATT 100 DB"
395 '----- User filter No. 3: 14-kHz notch filter
400 IEC OUT 20,"SENS:UFIL3:NOTC ON"
410 IEC OUT 20,"SENS:UFIL3:CENT 14 KHZ"
420 IEC OUT 20,"SENS:UFIL3:WIDT 500 HZ"
430 IEC OUT 20,"SENS:UFIL3:ATT 100 DB"
435 'The 3 customized filters defined above are used for RMS
436 'measurements; the bandpass filter for increasing the filter slope
437 'is used twice.
440 IEC OUT 20,"SENS:FUNC 'RMS'"
450 IEC OUT 20,"SENS:FILT1:UFIL1 ON":'          Two bandpass filters for
460 IEC OUT 20,"SENS:FILT2:UFIL1 ON":'        increasing the filter slope
470 IEC OUT 20,"SENS:FILT3:UFIL2 ON":'                12-kHz notch filter
480 IEC OUT 20,"SENS:FILT4:UFIL3 ON":'                14-kHz notch filter
    :
```

Filter curve obtained in a sweep from 9 to 17 kHz:

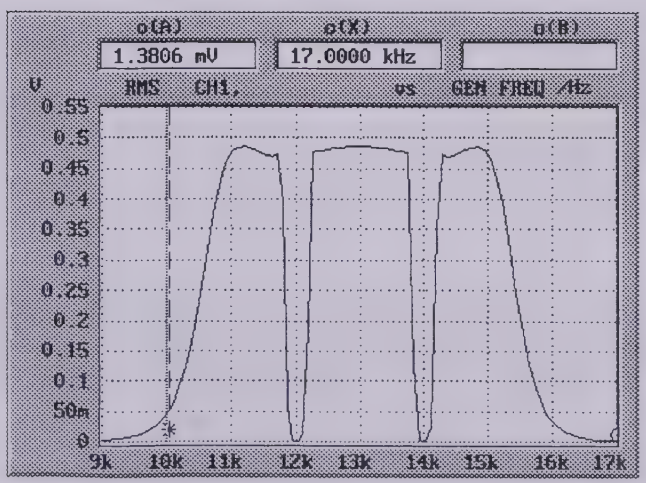


Fig. 3-11 Filter curve: steep bandpass filter + 2 notch filters

3.15.13 Finding a File

UPL provides no special command to find out whether a file has been stored on the UPL hard disk or on a floppy.
Remedy:
If an attempt to copy the file in a temporary file is not followed by an error message, the file already exists.

```
     :
100 File$ = "'C:\UPL\USER\MY.SCO'":' File of interest
110 IECOUT 20,"MMEM:COPY "+File$+",'TMP.TMP'"
120 IECOUT 20,"SYST:ERROR?": IECIN 20,E$
130 IF LEFT$(E$,1)="0" THEN
140   PRINT "File available!"
150 ELSE
160   PRINT "File not available!"
170 ENDIF
     :
```

3.15.14 Readout of Error Queue

The error queue can be read out after each command or by means of an SRQ interrupt routine if an error has occurred (see section 3.7.4.5 Error Queue Query)
The program below is a routine for reading out the error queue until it is empty.

```
     :
1290Errqueue:
1300 IEC OUT 20,"SYST:ERR?": '    Reads out error queue until queue is empty
1310 IEC IN 20,E$
1320 IF LEFT$(E$,1)="0" THEN RETURN:'                    Quits error routine
1330 PRINT "Contents of error queue: ";E$: GOTO Errqueue
     :
```

3.15.15 Command Synchronization

The synchronization modes realized in the example below are described in section 3.6.8, Command Synchronization.
Use commands *WAI, *OPC? or *OPC with SRQ to terminate a specific action before a new one is executed. Through suitable programming the controller can be made to wait for a specific action to be completed (see section 3.6.8.3 Comparison of Synchronization Capabilities).
There are two events in the UPL which have to be waited for before the next command can be executed:

- End of calibration
- End of measurement

Selection of an instrument with automatic calibration is used as an example for demonstrating the three synchronization methods. The following command should only be sent when the automatic calibration is completed. For more detailed information refer to section 3.6.8.1 Wait for End of Calibration.

3.15.15.1 Command Synchronization with *WAI

```
IECOUT 20,"INSTrument2 A100;*WAI":'        Selects new analog instrument and
                                          waits with *WAI for end of calibration
```

3.15.15.2 Command Synchronization with *OPC?

```
IECOUT 20,"INSTrument2 A100":'                    Selects new analog instrument
IECOUT 20,"*OPC?":'              Sends OPC?. Calibration is terminated when
IECIN 20,A$:'                                     the response "1" is received.
```

3.15.15.3 Command Synchronization with *OPC and SRQ

Command synchronization with *OPC and SRQ is described in advance of section 3.15.16 Service Request, which should best be read through first. Waiting for end of calibration with *OPC and SRQ after an instrument selection is again used as an example.

Procedure:

- set Operation Complete bit (OPC) in the Event Status Register,
- set ESB bit 5 in the Status Byte Register
- activate SRQ handler,
- call up change of instrument with automatic calibration,
- output synchronization command *OPC,
- wait in a loop for SRQ (end of calibration).

```
1057 '****************** Setting up SRQ ********************************
1058 IEC TERM 10:'                                  Line Feed as terminator
1059 IEC TIME 10000.'                             IEC/IEEE-bus timeout 10 s
1060 IEC OUT 20,"*CLS"
1061  'Enable OPC (Operation Complete) in the Event Status Register
1062  '                                 +---+---+---+---+---+---+---+---+
1063  '                                 | d7| Event Status Register | d0|
1064  '                                 |POW|USR|CME|EXE|DDE|QUE|   |OPC|
1065  IEC OUT 20,"*ESE 1": '            | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
1066  '                                 +---+---+---+---+---+---+---+---+
1067  'Trigger SRQ through entry in the Event Status Register (d5=1)
1068  '                                 +---+---+---+---+---+---+---+---+
1069  '                                 | d7|  Status Byte Register | d0|
1070  '                                 |SOR|RQS|ESB|   |SQR|   |   |   |
1071  IEC OUT 20,"*SRE 96": '           | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
1072  '                                 +---+---+---+---+---+---+---+---+
1073 ON SRQ1 GOSUB Srqintr:'   Activate SRQ handler of IEC/IEEE bus No. 1
  :
1080 IECOUT 20,"INSTrument2 A100":' Instrument change with autom. calibr.
1090 IECOUT 20,"*OPC":'                          Synchronization command
  :
1100 REPEAT
1110  'Other tasks may be performed as long as no SRQ is appears.
1120  'Signalled by a count on screen.
1130  Count=Count+1: PRINT Count
1140 UNTIL Srqflag=0:'           Flag = 1 when calibration is completed
  :
2000 '** Standard SRQ interrupt routine shown in section 4.15.1.2 ***
2010 Srqintr:
2020 IEC SPL 20,Sb%: '               Reads in Status Byte via Serial Poll
2040                                    :
```

3.15.16 Service Request

As can be seen from the introduction to the SRQ standard routine below, a Service Request routine requires an extended initialization of the UPL.
The SRQ standard routine uses Serial Poll for processing SRQ . This SRQ routine is used in almost all demo programs but for the sake of clarity it is not listed each time (remark in program code). The program example in section 3.15.16.2 SRQ Interrupt Routine with Parallel Poll, demonstrates SRQ handling by means of Parallel Poll which should be used to speed up identification of the instrument raising the SRQ when several IEC/IEEE-bus instruments are connected.
Same as with all other program examples it is assumed that IEC/IEEE-bus address 20 is set on the UPL to be controlled.

3.15.16.1 SRQ Interrupt Routine with Serial Poll

The examples below for initializing an SRQ and the SRQ interrupt routine are suggestions which can be modified as required by the specific application.
Serial Poll SRQ and the Serial Poll SRQ interrupt routine are initialized in this or a similar form in almost all program examples.

3.15.16.1.1 Initialization of Serial Poll SRQ

```
     :
100 '************ Initializing Serial Poll SRQ ***************
110 IEC TERM 10:' IEC/IEEE-bus terminator = Line Feed
120 IEC TIME 10000: ' IEC/IEEE-bus waiting time 10 s
130 IEC OUT 20,"*CLS":'Resets Status Register
140 'Enables error bits in the Event Status Register
150 '                                +---+---+---+---+---+---+---+---+
160 '                                | d7| Event Status Register | d0|
170 '                                |POW|USR|CME|EXE|DDE|QUE|   |OPC|
180 IEC OUT 20,"*ESE 61": '          | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
190 '                                +---+---+---+---+---+---+---+---+
200 'Enables d5 for SRQ trigger through Event Status Register
210 '                                +---+---+---+---+---+---+---+---+
220 '                                | d7|  Status Byte Register | d0|
230 '                                |SOR|RQS|ESB|   |SQR|   |   |   |
240 IEC OUT 20,"*SRE 96": '          | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
250 '                                +---+---+---+---+---+---+---+---+
260 Srqflag=0
270 ON SRQ1 GOSUB Srqintr: ' Activates SRQ handler
     :
```

3.15.16.1.2 Serial Poll SRQ Routine

The following standard SRQ interrupt routine is used in almost all the program examples. It displays the reason for the SRQ and the contents of the error queue on the controller monitor and signals to the main program with `Srqflag = 1`, that a SRQ has occurred.

```
1000Srqintr:
1010 ' ***********************************************
1020 ' ******* Standard SRQ Interrupt Routine ********
1030 ' ***********************************************
1040 IEC SPL 20,Sb%: ' Read-in of Status Byte
1050 IF (Sb% AND 64)=0 THEN GOTO Ret: ' No response in the case of false
alarm
1060 Srqflag=1
1070 PRINT "Status Byte Register = ";Sb%
1080 IF (Sb% AND 1)   THEN PRINT " SRQ->Not used"
1090 IF (Sb% AND 2)   THEN PRINT " SRQ->Not used"
1100 IF (Sb% AND 4)   THEN PRINT " SRQ->Not used"
1110 IF (Sb% AND 8)   THEN PRINT " SRQ->Questionable-status bit"
1120 IF (Sb% AND 16)  THEN PRINT " SRQ->Not used"
1130 IF (Sb% AND 32)  THEN PRINT " SRQ->Event-status bit"
1140 IF (Sb% AND 64)  THEN PRINT " SRQ->Summary bit"
1150 IF (Sb% AND 128) THEN PRINT " SRQ->Operation-status bit"
1160 '
1170 IEC OUT 20,"*ESR?": ' Read-in of Status Register
1180 IEC IN 20,Es$
1190 PRINT "Event Status Register = ";Es$
1200 IF (VAL(Es$) AND 1)   THEN PRINT " ESR->Operation-complete bit"
1210 IF (VAL(Es$) AND 2)   THEN PRINT " ESR->Not used"
1220 IF (VAL(Es$) AND 4)   THEN PRINT " ESR->Query-error bit"
1230 IF (VAL(Es$) AND 8)   THEN PRINT " ESR->Device-dep. error bit"
1240 IF (VAL(Es$) AND 16)  THEN PRINT " ESR->Execution-error bit"
1250 IF (VAL(Es$) AND 32)  THEN PRINT " ESR->Command-error bit"
1260 IF (VAL(Es$) AND 64)  THEN PRINT " ESR->User-request bit"
1270 IF (VAL(Es$) AND 128) THEN PRINT " ESR->Power-on bit"
1280 '
1290Errqueue:
1300 IEC OUT 20,"SYST:ERR?": ' Readout of error queue until queue is empty!
1310 IEC IN 20,E$
1320 IF LEFT$(E$,1)="0" THEN GOTO Ret
1330 PRINT "Contents of Error Queue:"
1340 PRINT " ";E$: GOTO Errqueue
1350 '
1360Ret: ON SRQ1 GOSUB Srqintr: RETURN:' Reactivates SRQ!
```

3.15.16.2 SRQ Interrupt Routine with Parallel Poll

3.15.16.2.1 Initialization of Parallel Poll SRQ

```
     :
100 '************ Initialization of Parallel Poll SRQ ********************
110 IEC TERM 10:'                        IEC/IEEE-bus terminator = Line Feed
120 IEC TIME 10000: '                         IEC/IEEE-bus waiting time 10 s
130 IEC OUT 20,"*CLS":'                               Resets Status Register
140 IEC OUT 20,"*ESE 121":' Enables OPC,DDE,EXE,CMD in the Event Status Reg.
150 IEC OUT 20,"*SRE 32":'              Enables Event Status bit as SRQ event
160 IEC OUT 20,"*PRE 255":'                   Enables all Parallel Poll lines
170 IEC PCON 20,1,6:'UPL identifies itself with 1 on line 6
180 IEC PCON 10,1,3:'Device with address 10 ident. itself with 1 on line 3
190 ON SRQ1 GOSUB Srqintr:'                              SRQ handler activated
     :
```

3.15.16.2.2 Parallel Poll SRQ Routine

```
740 '*********************************************************************
750 '******* Standard Parallel-Poll SRQ Interrupt Routine *************
760 '*********************************************************************
770Srqintr:
790 PRINT "SRQ has occurred!"
800 IEC PPL Pp%
810 IF (Pp% AND 32)<>0 THEN GOSUB UPLsrq
820 IF (Pp% AND 4)<>0 THEN GOSUB Adr10srq
825 ON SRQ1 GOSUB Srqintr: RETURN:' Reactivates SRQ
826 '
830UPLsrq:
840 '*********************************************************************
850 '**********          SRQ sent by UPL       ********************
860 '*********************************************************************
1040 IEC SPL 20,Sb%: ' Read-in of Status Byte
1060 Srqflag=1
1070 PRINT "Status Byte Register = ";Sb%
1080 IF (Sb% AND 1)   THEN PRINT " SRQ->Not used"
1090 IF (Sb% AND 2)   THEN PRINT " SRQ->Not used"
1100 IF (Sb% AND 4)   THEN PRINT " SRQ->Not used"
1110 IF (Sb% AND 8)   THEN PRINT " SRQ->Questionable status"
1120 IF (Sb% AND 16)  THEN PRINT " SRQ->Not used"
1130 IF (Sb% AND 32)  THEN PRINT " SRQ->Event Status"
1140 IF (Sb% AND 64)  THEN PRINT " SRQ->Summary"
1150 IF (Sb% AND 128) THEN PRINT " SRQ->Operation Status"
1160 '
```

```
1170 IEC OUT 20,"*ESR?": ' Read-in of Event Status Register
1180 IEC IN 20,Es$
1190 PRINT "Event Status Register = ";Es$
1200 IF (VAL(Es$) AND 1)   THEN PRINT " ESR->Operation complete"
1210 IF (VAL(Es$) AND 2)   THEN PRINT " ESR->Not used"
1220 IF (VAL(Es$) AND 4)   THEN PRINT " ESR->Query error"
1230 IF (VAL(Es$) AND 8)   THEN PRINT " ESR->Device-dep. error"
1240 IF (VAL(Es$) AND 16)  THEN PRINT " ESR->Execution error"
1250 IF (VAL(Es$) AND 32)  THEN PRINT " ESR->Command error"
1260 IF (VAL(Es$) AND 64)  THEN PRINT " ESR->User request"
1270 IF (VAL(Es$) AND 128) THEN PRINT " ESR->Power on"
1280 '
1290Errqueue:
1300 IEC OUT 20,"SYST:ERR?": ' Read-out of error queue until it is empty
1310 IEC IN 20,E$
1320 IF LEFT$(E$,1)="0" THEN RETURN
1330 PRINT "Contents of error queue:"
1340 PRINT " ";E$: GOTO Errqueue
1250 RETURN
1260 '
1270Adr10srq:
1280 '*****************************************************************
1290 '*******  SRQ sent by device with the address 10   *************
1300 '*****************************************************************
1310 IEC SPL 10,Sb%: '      Reset SRQ conditions for device with address 10
1320 'SRQ evaluation for device with the address 10
1330 '
1340 '
1350 RETURN
```

3.15.17 Readout of Cursor Position and Values

The values of a curve displayed on the UPL can be read by the controller, no matter whether the curve has been generated by a sweep or FFT or loaded into the UPL from a file or the controller. To do so the o- or * cursor has to be positioned as required. The value at the cursor crossing the curve or the difference value can be read out.
The great number of commands available for positioning the cursor are listed below.
To simplify the program examples for the various cursor display modes and the respective intercept points, the cursor position is indicated directly in the form of a value.

Table 3-16 Positioning the cursor on the displayed curve

Positioning the cursor for curve display	
Positioning the o cursor:	**Positioning the *-cursor:**

`"DISP:TRAC:CURS1:POS:MODE MIN1"`
Sets the horizontal o-cursor to the minimum value of **curve A** on the X axis.
	`"DISP:TRAC:CURS2:POS:MODE MIN1"`
	Sets the horizontal *-cursor for modes
	`"DISP:TRAC:CURS2:POS:MODE N12|D12|C12"`
	to the minimum value of **curve A** on the **X axis .**
	
	Sets vertical *-cursor for modes
	`"DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2"`
	to minimum of **curve A** on the **Y axis.**

`"DISP:TRAC:CURS1:POS:MODE MAX1"`
Sets horizontal o-cursor to maximum of **curve A.**
	`"DISP:TRAC:CURS2:POS:MODE MAX1"`
	Sets horizontal *-cursor for modes ☞
	`"DISP:TRAC:CURS2:POS:MODE N12|D12|C12"`
	to maximum of **curve A** on the **X axis.**
	
	Sets vertical *-cursor for modes
	`"DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2"`
	to maximum of **curve A** on the **Y axis**.

`"DISP:TRAC:CURS1:POS:MODE MIN2"`
Sets horizontal o-cursor to minimum of **curve B.**
	`"DISP:TRAC:CURS2:POS:MODE MIN2"`
	Sets horizontal *-cursor for modes
	`"DISP:TRAC:CURS2:POS:MODE N12|D12|C12"`
	to maximum of **curve B** on the **X axis.**
	
	Sets vertical *-cursor for modes
	`"DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2"`
	to minimum of **curve B** on the **Y axis.**

`"DISP:TRAC:CURS1:POS:MODE MAX2"`
Sets horizontal o-cursor to maximum of **curve B.**
	`"DISP:TRAC:CURS2:POS:MODE MAX2"`
	Sets horizontal *-cursor for modes
	`"DISP:TRAC:CURS2:POS:MODE N12|D12|C12"`
	to maximum of **curve B** on the **X axis.**
	
	Sets vertical *-cursor for modes ☞
	`"DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2"`
	to maximum of **curve B** on the **Y axis.**

`"DISP:TRAC:CURS1:POS:MODE VALue"`
`"DISP:TRAC:CURS1:POS 1000kHz"`
Sets horizontal o-cursor for modes
`"DISP:TRAC:CURS1:POS:MODE N12|D12|C12"`
to specified position on the **X axis.**
	`"DISP:TRAC:CURS2:POS:MODE VALue"`
	`"DISP:TRAC:CURS2:POS 1000kHz"`
	Sets horizontal *-cursor for modes
	`"DISP:TRAC:CURS1:POS:MODE N12|D12|C12"`
	to specified **X position.**
	
	Sets vertical *-cursor for modes ☞
	`"DISP:TRAC:CURS2:POS:MODE HL1|HL2|HLD1|HLD2`
	to specified position on the **Y axis.**

Table 3-17 Positioning the cursor for FFT spectrum display

Positioning the cursor for FFT spectrum display	
Positioning the o-cursor:	**Positioning the *-cursor:**

`"DISP:TRAC:CURS1:POS:MODE MARKer1"`
Sets vertical o-cursor to **X position** of marker if the latter was switched on with
`"DISP:TRAC1|2:MARK:MODE MAX|CURS".`
	`"DISP:TRAC:CURS2:POS:MODE MARKer1"`
	Sets vertical *-cursor to **X position** of marker if the latter was switched on with `"DISP:TRAC1|2:MARK:MODE MAX|CURS".`

`"DISP:TRAC:CURS1:POS:MODE NEXTmarker"`
Sets vertical o-cursor to **X position** of next harmonic if harmonics display was switched on with
`DISP:TRAC1|2:MARK:HARM ON.`
	`"DISP:TRAC:CURS2:POS:MODE NEXTmarker"`
	Sets vertical *-cursor to **X position** of next harmonic if harmonics display was switched on with
	`"DISP:TRAC1|2:MARK:HARM ON".`

`"DISP:TRAC:CURS1:POS:MODE IMAX1"` Sets vertical o-cursor to **X position** of highest Y value of **FFT curve A.**	`"DISP:TRAC:CURS2:POS:MODE IMAX1"` Sets vertical *-cursor to **X position** of highest Y value of **FFT curve A.**
`"DISP:TRAC:CURS1:POS:MODE IMAX2"` Sets vertical o-cursor to **X position of** highest Y value of **FFT curve B.**	`"DISP:TRAC:CURS2:POS:MODE IMAX2"` Sets vertical *-cursor to **X position** of highest Y value of **FFT curve B.**

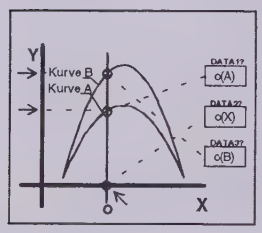
Note:

*Positioning of *-cursor partly depends on the set cursor mode `"DISP:TRAC:CURS2:POS:MODE N12|D12|C12|HL1|HL2|HLD1|HLD2"`. Function and effect of the individual cursor modes can be seen from the following diagrams and the associated program line 110*

Abbreviations used in the diagrams below:

o(A) = Y value at crosspoint of vertical o-cursor on curve A
o(B) = Y value at crosspoint of vertical o-cursor on curve B
o(X) = X value of vertical o-cursor
*(A) = Y value at crosspoint of vertical *-cursor on curve A
*(B) = Y value at crosspoint of vertical *-cursor on curve B
*(X) = X value of vertical *-cursor
*(Y) = Y value of horizontal *-cursor
*(X)AL = X value at left crosspoint of horizontal *-cursor on curve A
*(X)AR = X value at right crosspoint of horizontal *-cursor on curve A
*(X)BL = X value at left crosspoint of horizontal *-cursor on curve B
*(X)BR = X value at right crosspoint of horizontal *-cursor on curve B

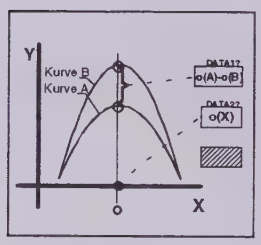
Cursor data for traces can be read out without restrictions as from UPL program version 2.10 onwards.!




```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT": ' Activates o-cursor 1
110 IEC OUT 20,"DISP:TRAC:CURS1:MODE N12"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": '  at 1000 Hz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000 Hz"
```

Analogously, **CURS2** activates the ***-cursor** yielding the values *(A), *(X) and *(B)

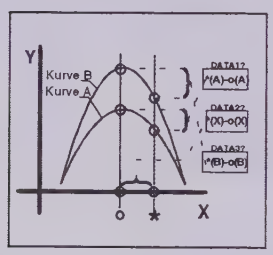
Fig. 3-12 Cursor data o(A), o(X), o(B), *(A), *(X), *(B)




```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT": ' Activates o-cursor 1
110 IEC OUT 20,"DISP:TRAC:CURS1:MODE D12"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": ' at 1000 Hz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000 Hz"
```

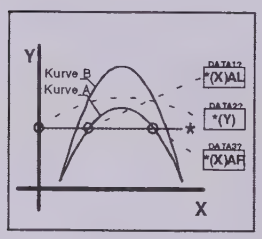
Analogously, **CURS2** activates the ***-cursor** yielding the values *(A) - *(B) and *(X)

Fig. 3-13 Cursor data o(A)-o(B), o(X), *(A)-*(B), *(X)




```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT;CURS2 ACT": '   Activates
                                                  o- and *-cursors
110 IEC OUT 20,"DISP:TRAC:CURS2:MODE C12"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": 'o-cursor 1 kHz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000 Hz"
140 IEC OUT 20,"DISP:TRAC:CURS2:POS:MODE VAL": '*-cursor 2 kHz
150 IEC OUT 20,"DISP:TRAC:CURS2:POS 5000 Hz"
```

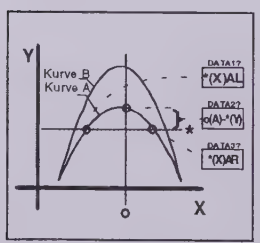
Fig. 3-14 Cursor data *(A)-o(A), *(X)-o(X), *(B)-o(B)




```
100 IEC OUT 20,"DISP:TRAC:CURS2 ACT": ' Activates *-cursor
110 IEC OUT 20,"DISP:TRAC:CURS2:MODE HL1"
120 IEC OUT 20,"DISP:TRAC:CURS2:POS:MODE VAL": ' Positions *-
cursor to
                                        Y value 0.2 V
130 IEC OUT 20,"DISP:TRAC:CURS2:POS 0.2 V"
```

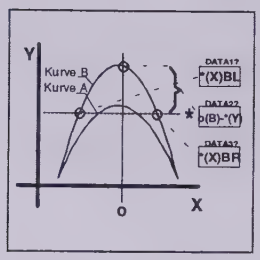
Analogously, cursor ...**CURS2:MODE HL2** yields values *(X)BL, *(Y) and *(X)BR for **curve B.**

Fig. 3-15 Cursor data *(X)AL, *(Y), *(X)AR




```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT;CURS2 ACT": ' Activates
                                                  o- and *-cursors
110 IEC OUT 20,"DISP:TRAC:CURS2:MODE HLD1"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": '  Positions
                                          o-cursor on 1000 Hz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000.0 Hz"
140 IEC OUT 20,"DISP:TRAC:CURS2:POS:MODE VAL": '  Positions
                                        *-cursor on Y value 0,2 V.
150 IEC OUT 20,"DISP:TRAC:CURS2:POS 0.2 V"
```

Fig. 3-16 Cursor data *(X)AL, o(A)-*(Y), *(X)AR




```
100 IEC OUT 20,"DISP:TRAC:CURS1 ACT;CURS2 ACT": ' Activates
                                                  o- and *-cursors
110 IEC OUT 20,"DISP:TRAC:CURS2:MODE HLD2"
120 IEC OUT 20,"DISP:TRAC:CURS1:POS:MODE VAL": '  Positions
                                                 o-cursor on 1000 Hz
130 IEC OUT 20,"DISP:TRAC:CURS1:POS 1000.0 Hz"
140 IEC OUT 20,"DISP:TRAC:CURS2:POS:MODE VAL": '  Positions
                                                   *-cursor on Y value 0.2 V
150 IEC OUT 20,"DISP:TRAC:CURS2:POS 0.2 V"
```

Fig. 3-17 Cursor data *(X)BL, o(B)-*(Y), *(X)BR

Readout of cursor values

DATA1?, **DATA2?** and **DATA3?** values are read in with the following commands:

```
IECOUT 20,"DISP:TRAC:CURS:DATA1?":IEC IN 20,"D1$
IECOUT 20,"DISP:TRAC:CURS:DATA2?":IEC IN 20,"D2$
IECOUT 20,"DISP:TRAC:CURS:DATA3?":IEC IN 20,"D3$
```

Values are output with the unit indicated in the display.

3.15.18 Call a BASIC-Macro

With the UPL, setting and measurement sequences can be written as BASIC programs or recorded using the built-in program generator (see 3.15.3 Command Logging - Converting B10 into IEC/IEEE-Bus Commands). Option UPL-K2 (Universal Autorun Control) is required. The generated BASIC programs can be stored (preferred file extension: .BAS) and called and used in various ways (see Macro operating).

The following example illustrates how a BASIC macro is called by means of an IEC/IEEE-bus control program in the programming language C and the IEC/IEEE-bus driver GPIB.COM from National Instruments:

Example 1:
BASIC macro transfers a measurement result in a measurement-result buffer to the control program

BASIC macro:

A short program is written under Universal Autorun Control UPL-B10 to trigger a level in channel 1. To demonstrate that any data can be transferred to the IEC/IEEE-bus control program as floating-point values via the measurement-result buffers, the level of channel 1 (line 30) is copied into the measurement-result buffer of channel 2 (line 40), from where it is read with the aid of the IEC/IEEE-bus control program.
This BASIC macro is stored in the UPL under the file name LEV_CH1.BAS.

```
10 UPL OUT "INIT:CONT OFF;*WAI"
20 UPL OUT "*TRG;*WAI"
30 UPL OUT "SENS:DATA?": UPL IN A$: ' level of channel 1 ...
40 UPL OUT "SENS:DATA2 "+A$: '... copying into buffer of channel 2
50 END
```

How to proceed:

- Press the F3 key to switch from the UPL user interface to Universal Autorun Control.
- Type the five lines shown above.
- Store program with SAVE LEV_CH1.BAS.
- Press the F3 key again to return to UPL user interface.

The following IEC/IEEE-bus control program calls the BASIC macro in the UPL with the command SYST:PROG:EXEC 'LEV_CH1.BAS'. There is a delay until serial polling indicates that bit 14 (RUN) has changed from 1 to 0 in the OPERation register; this indicates that the BASIC macro has been executed.
The measurement result is read from channel 2's measurement-result buffer and displayed on the screen.

IEC/IEEE-bus control program in controller:

```
/*************************************************************************
* A BASIC program in UPL triggering a level-measurement result in channel 1
* To be started as a BASIC macro from the controller
* Measurement result to be output at the controller
*************************************************************************/
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <conio.h>
#include <bios.h>
#include "C:\NI-GPIB\C\DECL.H"

void report_error(int fd, char *errmsg)
{

   fprintf(stderr, "Error %d: %s\n", iberr, errmsg);
   if (fd != -1) {
      printf("Cleanup: taking board off-line\n");
      ibonl(fd,0);
   }
getch();
exit(1);              /* abort program */
}

void befout (int upl, char *befstr)
{
   ibwrt(upl, befstr,(long)strlen(befstr));
   if (ibsta & ERR)
      report_error (upl, "Could not initialize UPL");
}

void queryin (int upl, char* reading)
{
 ibrd(upl, reading, 20L);
  if (ibsta & ERR)
   report_error (upl, "Could not read data from UPL");
  reading[ibcnt-1] = '\0'; /* Overwrites line feed with string terminator */
}

void main()
{
int    upl;           /* File descriptor for UPL */
int    i;
char   reading[20]; /* UPL measurement results */
long count = 0;
char stb;

if ((upl = ibdev(0, 20, 0, T10s, 1, 0)) < 0)
 report_error (upl, "Could not initialize UPL");

befout (upl,"*ESE 0"); //Disables information from event status register
```

```
befout (upl,"*SRE 0"); //Disables SRQ

/* The 1 -> 0 transition of bit 14 (RUN) in the OPERation register
   should set bit 7 (OPER) in the STB. The STB is read by means
   of serial poll until the event has occurred. */

befout (upl,"STAT:OPER:NTR 16384");  /* Enables 1->0 transition of bit 14 */
befout (upl,"STAT:OPER:PTR 0");       /* Disables 0->1 transition of bit 14
*/
befout (upl,"STAT:OPER:ENAB 16384"); /* Enables bit 14 for STB */

/* The BASIC program LEV_CH1.BAS in the UPL working directory writes
    the level measured in channel 1 to the measurement-result buffer of
channel 2
   to demonstrate data transfer via the measurement-result buffers. */

for (i=1; i <= 10; i++)
 {/* Reads 10 measurement results via the BASIC macro LEV_CH1.BAS */
  /* Reading the EVENt part of the OPERation register deletes the
     OPER bit in the status byte register! */
  befout (upl,"STAT:OPER:EVEN?");
  queryin (upl,reading);

  befout (upl,"SYST:PROG:EXEC 'LEV_CH1.BAS'"); // Starts the BASIC macro

  /* When the RUN bit (bit 14) in the OPERation register changes from 1 to
     0, the BASIC macro has been executed and the measurement
     result can be read from the measurement-result buffer. */
  stb = 0;
  while ((stb & 0x80) == 0)   // Serial poll is performed until
   {                          // bit 7 (OPER) in the STB is set to 1.
    ibrsp (upl,&stb);         // Serial poll of the status byte register
    if ((count++ % 100) == 0) // Progress counter while
     printf ("+");            // waiting for bit 7 = 1 */
   }

   /* The level of channel 1 can be read from the channel-2 measurement-
      result buffer, where it was stored by the BASIC macro. */
  befout (upl,"SENS:DATA2?");
  queryin (upl,reading);
  printf ("\n%s\n",reading);
 }

printf ("Any key:\n");
getch ();
ibonl(upl, 0);  /* Take UPL off-line */
}
```

Data transfer between BASIC macro and controller via the measurement-result buffers:

The measurement-result buffers can be written to so as to transfer data between the BASIC macro and the controller. The measurement results calculated by the macro can thus then be displayed in the UPL environment, which is familiar to the user.

Furthermore, fast exchange of floating-point parameters and floating-point measurement results between the UPL macro and the controller is possible via the measurement-result buffers. The following commands are available for the data exchange:
SENS1:DATA1, SENS1:DATA2
SENS2:DATA1, SENS2:DATA2
SENS3:DATA1, SENS3:DATA2

Note:
If the measurement results are not to be overwritten by the UPL measurement task, make sure the measurement task is halted, ie no measurement or sweep is being performed, while the measurement results are being written.

Example 2:
BASIC macro transfers a set of data in a block buffer to the control program

BASIC macro:

A short program is written under Universal Autorun Control UPL-B10. This program writes any set of data into the block buffer specially generated for BASIC macros. The data are then read from this buffer by the IEC/IEEE-bus control program.
This BASIC macro is stored in the UPL under BLK.BAS.

```
10 DIM A(1000): Frq=100: A(0)=X
20 FOR I=1 TO 999: ' 1000 log. frequency values  ...
30 Frq=Frq*1.00503: A(I)=Frq: ' ... 100 Hz to 15 kHz
40 NEXT I
50 UPL BLOCKOUT A(0),1000
60 UPL OUT "SYST:PROG"
70 END
```

Proceed as for example 1.

The following IEC/IEEE-bus control program calls the BASIC macro in the UPL with the command `SYST:PROG:EXEC 'BLK.BAS'`. There is a delay until serial polling indicates that bit 14 (RUN) in the OPERation register has changed from 1 to 0. This shows that the BASIC macro has been executed.

The block data are read from the block buffer and displayed on the screen.

IEC/IEEE-bus control program in the controller:

```
First part of program as in example 1
            :
            :
befout (upl,"SYST:PROG:EXEC 'BLK.BAS'"); // Starts the BASIC macro
stb = 0;
while ((stb & 0x80) == 0) // Serial poll is performed until
   {                      // bit 7 (OPER) in the STB is set to 1.
    ibrsp (upl,&stb);
    if ((count++ % 100) == 0) // Progress counter while
     printf ("_");            // waiting for bit 7 = 1  */
   }

  /* Determines number of values in the block buffer */
  befout (upl, "SYST:PROG:POIN?");
  queryin (upl,reading);
  points = atoi (reading);
  printf ("\nBlock buffer contains %d values. Display values...\n",points);
  getch();

 /* Read values from block buffer */
  befout (upl,"SYST:PROG?"); /* Fetch contents from block buffer.
                    The values are available as ASCII characters separated
                    by commas */
  ibeos (upl,0x142C); //Stringterminator = ','
  for (i = 0; i < points-1; i++)
```

```
   {// Each value is read up to the comma
    queryin (upl,reading);
    fltvalfield[i] = atof (reading);
   }
  // Before the last value has been read, the string terminator ...
  ibeos (upl,0x140A); //... is reset to AF.
  queryin (upl,reading);
  fltvalfield[i] = atof (reading);

  // Values are output on the screen.
  for (i = 0; i < points; i++)
    printf ("%d: %f\n", i+1,  fltvalfield[i]);

printf ("Any key:\n");
getch ();
ibonl(upl, 0);  /* Take UPL off-line */
}
```

3.15.19 Third analysis - Output of Block Data

Example of Programming for Universal Autorun Control UPL-B10:

The following program example shows the settings for the third analysis measurement function of a noise signal (1/3 OCTAVE measurement function in ANALYZER panel).

Important!
The current level values of the 1/3 octave analysis are available under Scan Count 1 (line 200), the maximum level values of the max. hold function (line 60) under Scan Count 2 (line 210). The frequency list is queried with TRAC? LIST (line 140) , the max. hold level values with TRAC? TRAC (line 260).

```
10 REM ******** Third analysis - read out of Block Data ******************
20 UPL OUT "*RST": '                                        UPL default setup
30 UPL OUT "SOUR:FUNC RAND": '                    Noise signal for generator
40 UPL OUT "INP:TYPE GEN2": '   Internal connection to generator channel 2
50 UPL OUT "SENS:FUNC 'THIR'": '                 Switches on Third Analysis
60 UPL OUT "SENS:VOLT:INTV:MODE FOR": '      Max-hold function switched on
70 UPL OUT "DISP:TRAC:OPER FFTL": '              FFT data in tabular form
80 UPL OUT "INIT:CONT OFF": '              Selects single-measurement mode
90 UPL OUT "*TRG;*WAI": '                     Triggers single-measurement
100 UPL OUT "TRAC:POIN? LIST": '         Request count of frequency values
110 UPL IN A$: Count=VAL(A$): '         Read out count of frequency values
120 PRINT "Count of freq. values:";Count: INPUT "Go on......";A$
130 DIM X(Count): '                                Field for frequency values
140 UPL OUT "TRAC? LIST": '                         Read out frequency values
150 UPL BLOCKIN X(0): '   Loads frequency block data into the data field X
160 FOR I=0 TO Count-1
170 PRINT X(I);"Hz ": '                              Display frequency values
180 NEXT I
190 UPL OUT "DISP:TRAC:OPER SPEC": '   COUNT selection only avail. in SPEC
200 REM UPL OUT "DISP:TRAC:COUN 1": ' Choose current values of T. Analysis
210 UPL OUT "DISP:TRAC:COUN 2": ' Choose Max-hold values of Third Analysis
220 UPL OUT "TRAC:POIN? TRAC": '            Request count of level values
230 UPL IN A$: Count=VAL(A$): '            Read out count of level values
240 PRINT : PRINT "Count of level values: ";Count: INPUT "Go on......";A$
250 DIM Y(Count): '                                 Field for level values
260 UPL OUT "TRAC? TRAC": '                  Read out Max-hold level values
270 UPL BLOCKIN Y(0): '       Loads level block data into the data field Y
280 FOR I=0 TO Count-1
290 PRINT Y(I);"V ": '                                Display level values
300 NEXT I
310 END
```

3.16 Automatic Control of UPL with R&S BASIC

Important:

The software described below is an accessory for UPL and available under the designation UPL-B10 . It is not part of the equipment supplied with UPL.

The program examples in the paths C:\UPL\B10_EXAM\EXAM1.BAS ff of the UPL software can be directly run on the UPL with Universal Sequence Controller UPL-B10. Files with the extension .SAC are setup files required by the examples for setting the UPL. Files with the extension .TXT provide the program code of the examples as an ASCII file and can be accessed by any editor.

3.16.1 Use

Executing frequent test sequences in a fast and reproducible way, summing up the results and creating a valuable documentation, these are the applications of the UPL universal sequence controller using R&S BASIC. These automatic measurements, consisting of generator and analyzer functions of the UPL, are used for a full characterization of instruments and components in production or the test shop and for ensuring and monitoring the characteristics of system and transmission devices.

A universal sequence controller for automatic measurements does not only have to control the instrument functions, but must also be able to evaluate the measurement results and branch in the program. Besides, operator prompting with confirmations and indications is expected. Furthermore, synchronization with a time base or external events may be required. Thus, some programming is sometimes required, but it should be as simple as possible. Therefore, a complete BASIC interpreter with optimally integrated commands is used for operation of the measuring instrument. A simple keystroke permits to change between normal operation of the measuring instrument and BASIC. The command extensions for the instrument control feature the same structure as the IEC/IEEE-bus commands, which in turn comply with the international SCPI standard.

3.16.2 Scope of Functions

The UPL provides about 600 elements (ie functions in the programming language) and almost as many keywords as parameters. Therefore, users not wishing to do any programming, but also experts will appreciate the integrated program generator. Every input via front panel or keyboard for setting the UPL is recorded in logging mode and added to the program as a complete program line. Simple test sequences are thus completely programmed without having typed a single line. There is no need to check the correct syntax, the created program can be easily read due to the standard SCPI notation and is thus simple to modify and supplement.

R&S BASIC with easy-to-handle IEC/IEEE-bus commands that are optimally incorporated into the syntax can also control further IEC/IEEE-bus devices without the need for an external controller. (This requires the Remote Control option UPL-B4). Likewise, it is straightforward to operate the serial interface and write and read files for connection with peripheral devices or other programs.

For graphical output, BASIC can fully make use of the UPL software: Graphs with sophisticated scaling and labelling, bargraphs, bargraphs with trailing pointers, all of them also with automatic scaling depending on the measured value, are still available. In addition, the graphics commands belonging to BASIC can also be used.

If the UPL is to be controlled by an external controller in a test system, two REPLACE commands can be used to convert all UPL IN/OUT instructions into IEC/IEEE commands (IEC IN/OUT). This constitutes the basic program for controlling the UPL.

3.16.3 Preparation for Use

If the Universal Sequence Controller UPL-B10 is ordered together with the UPL it is immediately ready for use. When retrofitted, it has to be enabled by means of an installation key. A key matching the serial number of the UPL is supplied to the user to activate the software.

Subsequently, a memory model for BASIC can be selected by calling UPLSET. The user has to indicate how much memory he wants to reserve for the BASIC program and BASIC data (variables). Since the UPL cannot simultaneously be remote-controlled via the IEC/IEEE bus and the Universal Sequence Controller UPL-B10, the user must choose between the two modes by means of UPLSET. The files CONFIG.SYS and UPL.BAT are thus changed.

-UPLSET contains a menu through which the user is guided:

➢ Enter "UPLSET" and "↵" after the prompt c:>.
The selected operating mode is maintained even after instrument switch-off.

To estimate the required memory, the following empirical values are given: A typical BASIC line requires about 25 bytes. A 13k program memory is thus sufficient for about 500 lines or 10 pages of program. The remaining empty memory can be polled in BASIC with FRE(1). A variable in BASIC requires about 15 bytes (depending on the length of the name), and a field with floating-point numbers requires 8 bytes for each index. FRE(o) indicates the remaining storage area.

The memory should not be oversized, since the program may be limited in its speed from a certain size onwards (see also Section 3.16.4.11 UPL/Basic Memory Management - UPL-B10). If the preset values are not exceeded, the UPL operates at full speed.

In the case of first installation, the UPL must be booted anew; otherwise this is only necessary when the memory model is changed. UPLSET can also be called in order to poll about the currently active memory allocation. If the UPL is to operate again as a measuring instrument controlled externally via IEC/IEEE bus, UPLSET can be used to return to this mode.

3.16.4 Operation

In the following, a distinction is made between BASIC and the UPL program, the latter including all routines except BASIC (i.e. the test, readout, graphics output and input routines).

3.16.4.1 Switchover between UPL and BASIC Entry Mode

- **Switchover from UPL to BASIC entry mode**:
  Use function key **F3** on the **external keyboard** or **BACKSP** on the front panel. With BASIC in the entry mode, the fields for reading out measured values are displayed at the upper edge irrespective of whether full graphics display is selected in the UPL or not. The field below down to the softkeys is available to BASIC.
  Possible error messages after pressing the F3 key: When the message "BASIC not installed" is displayed, BASIC has not been installed at all or incorrectly. "Memory not available" indicates that a memory size exceeding the available space has been selected with UPLSET.

- **Entry in the BASIC mode:**
  All characters can be entered from the external keyboard as required. A limited control is also possible from the UPL front panel:
  Keys of the front-panel key blocks DATA/PANEL and EDIT as well as the CURSOR keys have the common functions.
  Exceptions:
  SELECT = blank
  +/- = - (minus)
  The keys of the CONTROL block as well as HELP, the tabulator and PgUp/Dn keys in the CURSOR/VARIATION block have no function.

  Letters cannot be output with the front-panel keys but the entry of numerals opens up plenty of possibilities for controlling a BASIC program without the burden of an external keyboard.

  While BASIC waits for a line entry (as after pressing of the "↵"-key), the UPL program continuous to run in the background and the measurement results are displayed. The effects of the settings made by BASIC can thus be observed immediately. However, after the first character has been entered, the UPL program is not called up any more. No measurements are performed and the printer spooler (HCOPY) does not run in the background until the entry is terminated with "↵".

  Note:

> *When the UPL is controlled with BASIC, printing with HCOPY is considerably slowed down as the available computing time must be divided up. There will be more time for the printout if the measurement is stopped using the STOP key on the front panel.*

- **Switching back from BASIC to UPL entry mode:**
  Key **F3** on the **external keyboard** or the keys **ENTER** and then **LOCAL** on the **front panel**.
  When switching back to UPL control the panels are completely restored to show the current settings as there may have been changes under BASIC. BASIC is inactive but the last-set status will be retained.

3.16.4.2 First Steps (Readout of Measurement Results)

Program example:
Triggering 10 measurement results and output on the screen.

- Press key F3 of the external keyboard from the UPL user interface. The result display field appears at the top of the screen, the softkey lines at the bottom. "R&S-BASIC version..." is displayed in the screen center.
- Enter the following program (including line numbers 10-90).

```
10 UPL OUT "*RST": '                                    UPL default setting
20 UPL OUT "INP:TYPE GEN2": 'Internal connection to generator channel 2
30 FOR I=1 TO 10
40  UPL OUT "INIT:CONT OFF;*WAI": '       Triggers a single measurement
50  UPL OUT "SENS:DATA?":  Requests function test result from channel 1
60  UPL IN M$: '                          Reads in measurement result
70 PRINT M$: '                              Prints measurement result
80 NEXT
90 END
```

- Start the program with F6:

Due to the default setting made with *RST (see Appendix A UPL Default Setup), the UPL generator produces a 1-kHz sinewave signal with a level of 0.5 V.
Command INP:TYPE GEN2 internally links generator channel 2 and analyzer channel 1 so that cabling between inputs and outputs is not required for this first test. The UPL analyzer performs 10 RMS measurements and the results are displayed on the UPL screen.

Note:

To display a measurement result on the screen it must first be triggered (line 40). After triggering a settled result is available which can be requested (line 50), read out (line 60) and displayed on the UPL screen (line 70).

- Return to manual operation: Press F3 on the external keyboard or ENTER and then LOCAL on the front panel.

3.16.4.3 Logging Mode

Function key F2 switches the logging mode on or off. The respective mode is indicated in the bottom righthand corner above the softkeys. In the case of "on", all entries used for setting the UPL are appended to the BASIC program as a command line. After switching to the BASIC mode, these new lines are displayed automatically and may be modified.

The BASIC commands for automatic control of the UPL differ only slightly from the commands for remote control via the IEC/IEEE bus. The program can easily be converted into the other commands using the BASIC command REPLACE (eg for controlling the UPL with an external controller). See also UPL-specific modifications of the BASIC manual, paragraph REPLACE. A detailed example is given in section 3.15.3 Command Logging - Converting B10 into IEC/IEEE-Bus Commands.

3.16.4.4 Differences to IEC/IEEE-Bus Remote Control

The differences between the R&S BASIC commands of the universal sequence controller and the R&S BASIC commands of the IEC/IEEE-bus control are illustrated by way of examples:

Delimiters of character strings, Timeout

R&S BASIC command	R&S IEC/IEEE-bus command
A delimiter need not be specified for the transfer of a character string.	10 IEC TERM 10 Controller expects LF as delimiter for an UPL response
Waits indefinitely for a response. However, in special cases the time can be monitored by querying bit d0 (OPC) of the Event Status Register in a loop until the bit assumes the value 1 which signals that a measurement result is available. The program example is given under "Other differences to IEC/IEEE-bus remote control" further down in this section.	10 IEC TIME 5000 The controller does not wait longer than 5 s for a response from the UPL before an IEC/IEEE-bus timeout is signalled.

Output of commands

R&S BASIC command	R&S IEC/IEEE bus command
10 **UPL OUT** "SOUR:FREQ 1000Hz" (sets generator frequency) Transfers a character string (constant in quotes, variable denoted with $ or a character string expression) to the UPL program.	10 IEC OUT 20, " SOUR:FREQ 1000Hz "

Reading in responses

R&S BASIC command	R&S IEC/IEEE-bus command
100 UPL OUT "SENS:DATA2?" 110 **UPL IN** A$ (transfers the measured value of channel 2 to the variable A$ for processing) Takes a character string from the UPL program. This may be a measured value or a queried setting. The information to be taken must first be defined in a query (command with question mark).	100 IEC OUT 20, "SENS:DATA2?" 110 IEC IN 20, A$

Output of block data

R&S BASIC command	R&S IEC/IEEE-bus command

`10 DIM A(20)`
`20 Frqval = 20`
`30 FOR I = 0 TO 19`
`40 A(I) = Frqval`
`50 Frqval = Frqval*1.44`
`60 NEXT I`
`70 UPL BLOCKOUT A(0),20`
`80 UPL OUT "sour:list:freq"`
(transfer of 20 values for a frequency list sweep to the UPL)
 	
UPL BLOCKOUT <array(i)>[,n]
 	
Stores block data in a reserved communication range of the UPL so that they can be transferred subsequently from BASIC to the UPL with an UPL OUT "...." command. This applies, for instance, to the transfer of lists or values for graphic display. The index **i** indicates the value from which onwards the data field is to be transferred. **n** defines the number of values. If **n** is not specified, the quantity defined with DIM will be used.
	`10 DIM A(20)`
	`20 ' Combines block data to a string`
	`30 Bef$="SOUR:LIST:FREQ"`
	`40 Frqval=20`
	`50 FOR I=0 TO 19`
	`60 Bef$=Bef$+STR$(INT(Frqval))`
	`70 IF I<19 THEN Bef$=Bef$+","`
	`80 Frqval=Frqval*1.44`
	`90 NEXT I`
	`100 IEC OUT 20,Bef$`

Reading out block data

R&S BASIC command	R&S IEC/IEEE-bus command

`10 DIM A(200)`
`20 UPL OUT "TRAC? TRAC"`
`30 UPL BLOCKIN A(0)`
`40 UPL OUT "TRAC:POIN? TRAC"`
`50 UPLIN A$:Count = VAL(A$)`
(loads a sweep list in the form of block data from the UPL into field A( ) of BASIC and loads the data into Count)
 	
UPL BLOCKIN <array(i)>
 	
loads block data (ie lists or a measurement sequence) from the UPL program into a data field (index variable) for further processing. Same as with UPL IN the data to be read must first be defined in a query (`sour:list:freq?`). **i** denotes the index from which the first value of a block is stored. The list is always used in full length, ie a sufficiently large data field has first to be defined with DIM.
	`10 DIM A (200)`
	`20 IEC OUT 20,"TRAC:POIN? TRAC"`
	`30 IEC IN 20,Count$: Count=VAL(Count$)`
	`40 IEC OUT 20,"TRAC? TRAC"`
	`50 IEC TERM 44: ' Sets string term. to ',' (0x2C = 44d)`
	`60 FOR I=0 TO Count-2: ' Reads in n - 1 values`
	`70 IEC IN 20,A$: DIM(I) = VAL(A$)`
	`80 NEXT I`
	`90 ' Reads last value`
	`100 IEC TERM 10: ' Resets string term. to LF`
	`110 IEC IN 20,A$: DIM(Count-1) = VAL(A$)`

Switchover to UPL user interface

R&S BASIC command	R&S IEC/IEEE-bus command
UPL GTL (Go To Local) With this command BASIC is quit and the UPL screen is displayed. Control is also transferred to the UPL and entries can be made in the UPL panels. To return to BASIC the F3 key has to be pressed. This means that in the program mode this command has the same function as the F3 key (switchover from BASIC to UPL). If the operator now presses F3, control is switched back and BASIC continues with the command that follows UPL GTL in the program. When entered in the BASIC direct mode, this command has the same function as the F3 key. ***Note:*** *After a BASIC program has been started with RUN, key F3 is disabled. It is enabled again only after END, STOP or abort (with Ctrl/Break)in the BASIC entry mode.* **UPL GTL U** (Go To Local, temporarily with UPL screen) This command is required when the UPL display should be used under BASIC. Thus an ongoing sweep or FFT can be monitored (provided a measurement was started before, the display is continuously updated) or values computed in BASIC are to be displayed. (These values have to be transferred first from BASIC to UPL using the UPL BLOCKOUT command). The panel displayed at the left of the graphics window can be used by BASIC for PRINT outputs. A line must not be longer than 26 characters, however, as otherwise the graphics window will be overwritten. After the UPL GTL U command, the screen scroll is stopped to avoid the graphic display being shifted and destroyed when the first or the last line is reached (in the case of uncontrolled PRINT outputs). Status lines 1 and 2 cannot be used either as this space is occupied by the UPL display. With this command the BASIC display is stored and the UPL screen displayed. Control is not transferred to the UPL, however, and entries cannot be made in the UPL panels. Immediately after display of the UPL screen, control is handed back to BASIC without the BASIC display being restored. Use the GTL B command described below to restore the BASIC display. After an UPL GTL U command and before terminating the program with END, STOP or abort (with Ctrl/Break or in case of a fault) the operator should restore the BASIC display as otherwise no entries can be made, eg in the UPL full-screen mode. As an aid for the operator, the BASIC display is automatically restored when the BASIC entry mode is reached (entry of commands or program instructions) with the consequence that UPL GTL B is performed immediately when UPL GTL U command is entered in the direct mode and the entry has no effect. **UPL OUT "DISP:ACT ON | OFF"** This command is of interest in conjunction with GTL U. The OFF state prevents the graphics display being updated after every control command as this might be disturbing and slow down program execution. With ON the display is completely restored and then continually updated. The OFF and ON commands are to be used together as a pair as otherwise the UPL graphics display is not restored, not even when the UPL is manually controlled.	`IEC LAD 20` `IEC GTL`

UPL GTL B (set BASIC screen)

This command is only needed with UPL GTL U. It restores the BASIC screen displayed before the UPL display set up with UPL GTL, UPL GTL U or with the F3 key (change from BASIC to UPL control).

UPL GTL G (draw UPL graphic)

This command is needed when the UPL graphics display is to be used under BASIC. The display is restored but not subsequently updated as is the case with UPL GTL U. Thus values computed in BASIC, for instance, can be displayed (the values have to be transferred first from BASIC to the UPL using the UPL BLOCKOUT command). The operator can make full use of the UPL graphics display with scales and labels.
The graphics display must be switched on of course (with command UPL OUT "disp:conf ...." using parameters xP or P, or previously in manual control). Note: Upon loading a setup, the 3-panel display may be selected which has the effect of switching off the graphics display. In case of doubt check the setting by changing to the UPL mode.
When the result output has been activated (set to display) using UPLOUT "disp:ann on" also the measurement results in the display field at the screen top are updated.
Contrary to F3, UPL GTL or UPL GTL U, the BASIC screen is not stored and the UPL display set up, but the UPL graphics display is integrated in the BASIC screen. Like any other graphic drawn under BASIC, the display is shifted together with the text when the cursor reaches the top or bottom edge. The graphic may also be overwritten by text (in this case the background is blanked) irrespective of whether this is useful or not.
When the display is shifted, which can always be prevented by adequately positioning the cursor (see section 3.16.4.8 STRINX.SYS Driver for Screen and Keyboard - UPL-B10), parts of the graphics display remain visible at the upper or lower edge of the scroll window as the scrolled parts are shifted in multiples of the text size, which do not correspond to the UPL graphic displayed.
Since the UPL graphic has become part of the BASIC screen it is always restored when the UPL display is switched over to BASIC with the F3 key. It is cleared together with the BASIC text screen using the sequence PRINT "Esc[2J". CLEAR also clears the screen or parts thereof (see section 3.16.4.5 UPL-specific Modifications to the Basic Manual - UPL-B10 under CLEAR).

Further differences to IEC/IEEE-bus remote control:

- An SRQ procedure cannot be programmed in R&S BASIC of the Universal Sequence Controller UPL-B10, ie the control program cannot perform other tasks while waiting for measurement results or error messages from the UPL. Error queue or the status registers must be queried cyclically in the control program.
- Since the UPL does not generate an SRQ for the Universal Sequence Controller UPL-B10, there is no need to determine the sender or source of the SRQ by means of a serial or parallel poll. This should not be mixed up with the possibility of using the UPL as an IEC/IEEE-bus controller and to control other instruments on the IEC/IEEE bus from the Universal Sequence Controller UPL-B10 (described in the manual R&S BASIC Interpreter supplied with the UPL-B10 option).
- Line messages like REN, GET, DCL, etc are not possible.
- The line message EOI denoting the end of a binary block cannot be used.
  Binary block data cannot be received. The command " FORMat REAL" is ineffective.
  Block data can only be received with command UPL BLOCKIN described above.
- In R&S BASIC of the Universal Sequence Controller UPL-B10 all common commands referring to SRQ control are not relevant. Respective information can be obtained from the table under 3.9

Common Commands.
An exception is the *OPC command. Although mainly intended to trigger an SRQ when a measurement result is relevant, under R&S BASIC this command may be used to wait for a measurement result in a loop by querying the bit d0 of the Event Status Register:

Example:

```
110 UPL OUT "*OPC;*TRG": ' Triggers measurement result
120 Brk=0: I=0
130 WHILE (Brk=0) AND (I<=100)
140  UPL OUT "*ESR?"
150  I=I+1: UPL IN Esr$: IF (VAL(Esr$) AND 1)<>0 THEN Brk=1: ' Queries OPC
160 WEND
170 IF I>100 THEN PRINT "Timeout": STOP
180 UPL OUT "SENS:DATA?": ' Requests measured value
190 UPL IN M$: PRINT M$: ' Reads and output measured value
```

- Common commands (3.13.1) and addressed commands (3.13.2) are not available for the Universal Sequence Controller UPL-B10.

- All registers and commands of the status reporting system which are not related to SRQ generation can be used:

*STB?	not usable
*SRE	not usable
*PRE	not usable
*IST?	not usable
***ESR?**	**usable**
*ESE	not usable
STATus:**OPER**ation**?**	**usable**
STATus:**QUES**tionable**?**	**usable**
STATus:**XQUE**stionable**?**	**usable**
SYSTem:**ERR**or**?**	**usable**

- ***Note:***

*If UPL with Universal Sequence Controller UPL-B10 is used as a controller for **other IEC/IEEE-bus devices** (described in the R&S BASIC Interpreter manual supplied with the UPL-B10 option), and should **again** be controlled by another controller as a talker/listener **on the IEC/IEEE bus**, IEC/IEEE-bus control must be released by the Universal Sequence Controller UPL-B10 with command IECRLC (IEC ReLease Control).*

3.16.4.5 UPL-Specific Modifications to the BASIC Manual

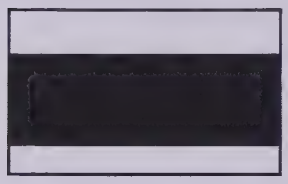
There are only a few modifications to the supplied standard BASIC manual which result from different conditions. In the part of the manual dealing with process controllers, the BASIC manual of the PSA and PAT controller versions is valid.

Softkey labelling and function keys
As against the standard BASIC manual, the function keys are shifted by 4 keys as F1 to F4 are assigned different functions in the UPL. The softkey labelling has been adapted accordingly for the UPL. Switchover between alphanumeric and graphics mode (F8) is not provided in the UPL.

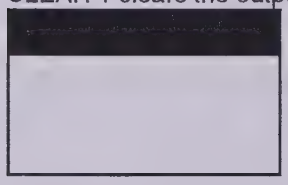
BYE
is a synonym for EXIT; description see under EXIT.

CLEAR [1 | 2 | 3]
This command clears the screen or parts of it. The size of the parts corresponds to the UPL panels or fields. The commands always clear the indicated parts irrespective of whether they are assigned UPL fields or not.

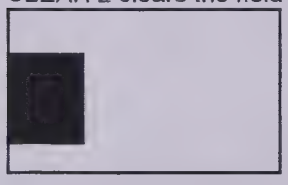
Without parameter specified, the upper part of the screen is cleared, however without the output field for measured values.



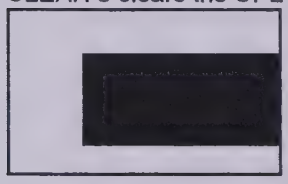
CLEAR 1 clears the output field for measured values



CLEAR 2 clears the field at the left of the graphic display.



CLEAR 3 clears the UPL graphics.



COLOR
should not be modified to avoid changing of the UPL graphics output. The colours are assigned as follows:

Pen	UPL colour mode	UPL b/w mode	
0	white	white	(background)
1	dark grey	white	
2	white	black	
3	red	black	
4	grey	grey	
5	yellow	light grey	
6	dark grey	dark grey	
7	yellow	dark grey	
8	green	grey	
9	green	black	
10	blue	black	
11	green	black	
12	yellow	grey	
13	cyan	dark grey	
14	black	black	
15	black	black	(preselected colour)

COPYOUT
is not supported. See GSAVE "LPT1".

EXIT (Synonym for BYE)
leaves the BASIC mode and returns to the UPL input mode and not to MS-DOS.

GRAPHIC
The interface name for putting out graphics on the screen is no longer GRAPH but GRAPX with the UPL.

GSAVE on LPT
is not supported. Instead, the HCOP:DEST <> remote-control command should be used for a printout of the display.

HELP
is not supported as a command.

HOLD
Note:

During the wait time the routines are not continued. Therefore, with long times, the wait time should better be implemented with a loop using TIME.

REPLACE
To allow also the comma to be contained in the REPLACE command as part of the string (and not as separator between the new and the old string), it has to be preceded by a backslash (\,).

Example 1:
old program: `100 UPL OUT A$`
`REPLACE UPL OUT, IEC OUT 20,`
new program: `100 IEC OUT 20,A$`

Example 2:
old program: `100 IEC IN 20, A$`
`REPLACE IEC IN 20\,, UPL IN`
new program: `100 UPL IN A$`

SCREEN
is not supported; SCREEN 18 (VGA mode with 16 colours/grey shades) is always set.

SET
The colour of the pen is selected from the colours described above under COLOR.

SHELL
is only supported with restrictions, since the remaining memory of approx. 60 Kbytes is too small; the MS-DOS command interpreter together with the program called must not exceed this memory size. However, this is the case with the internal and a few external MS-DOS commands (dir, del, md, cd etc, see MS-DOS manual).

VIEWPORT
The upper limit for y2 should be 294 so that the upper field remains vacant for readout of the measured values. In principal, there are no restrictions to the BASIC graphics commands, it is up to the user whether the area used by the UPL graphics is overwritten.

WINDOW
The preselected values are 0,639,0,**293.**

ZOOM
is not supported

3.16.4.6 BASIC Screen

The screen contains 30 text lines, 5 at the lower edge being reserved for softkeys and two lines for status indication. One status line is used by BASIC, the other is available to the user (see labels of status lines and softkeys).

Two modes are provided for the upper 25 lines: either BASIC uses all lines or the UPL builds up a field for the output of measured values at the top edge, where the measurement results are continuously updated. This field comprises 7 text lines and reduces the BASIC text window to 18 lines. The second mode is activated using UPL OUT "disp:ann on".

Inside the 25/18-line window, the text is scrolled when the cursor reaches the top or bottom edge. If this window contains a graphic, the latter is shifted as well. This also applies to graphics drawn by the UPL software. However, since the graphics are slightly larger than the text window, which is variable in steps of 16 pixels only (text size), they seem to be somewhat "torn". By positioning the text appropriately, the user must ensure not to write outside the text window (which causes a shift).

The command PRINT "Esc (2)" clears the 18- or 25-line window depending on the mode. The CLEAR command (without parameter) only clears the 18-line window (without the area reserved for the output of measured values). The BASIC extensions CLEAR 1½ 2 ½ 3 clear the panel fields or the output field for measured values irrespective of whether they contain UPL panels or not (see section 3.16.4.5 UPL-specific Modifications to the Basic Manual - UPL-B10).

If text is entered for BASIC, BASIC does not get the keyboard entries but reads out the screen contents. If graphics are superimposed on this text, it is possible that the character is not identified and BASIC responds with an error message. Even the space between the last character and the right-hand screen edge is significant if it can be interpreted as a blank or character. Therefore, the user should write at a "clean" position, or go to a position by scrolling the text before writing.

3.16.4.7 Control Commands Unsuitable for Logging

The control commands are described in detail in the UPL manual, classified according to their function and then in alphabetical order. Furthermore, almost all commands can be logged in manual operation, the commands being created in the correct notation and added to the program.

Commands for reading out measured values and control commands via the front-panel keys in the CONTROL block cannot be logged. They are briefly summed up in the following.

CONTROL key commands:

START	UPL OUT "init:cont on"
	UPL OUT "init"
SNGL	UPL OUT "init:cont off"
STOP	UPL OUT "abort"
HCOPY	UPL OUT "hcop"
LCD ON/OFF	UPL OUT "disp:enab on" adv. off
OUTPUT ON/OFF	-----
LOCAL	UPL GTL

Commands for reading out single measurement results:

Function CH1:	UPL OUT "sens:data?":UPL IN A¤
Function CH2:	UPL OUT "sens:data2?":UPL IN A¤
Input PEAK CH1:	UPL OUT "sens2:data?":UPL IN A¤
Input PEAK CH2:	UPL OUT "sens2:data2?":UPL IN A¤
Freq CH1:	UPL OUT "sens3:data?":UPL IN A¤
Freq CH2:	UPL OUT "sens3:data2?":UPL IN A¤
Phase:	UPL OUT "sens4:data2?":UPL IN A¤

Commands for reading out block data:

Trace A:	UPL OUT "trac? trac1":UPL BLOCKIN A(0)
Trace B:	UPL OUT "trac? trac2":UPL BLOCKIN B(0)
X values:	UPL OUT "trac? list1":UPL BLOCKIN X(0)
Z values:	UPL OUT "trac? list2":UPL BLOCKIN Z(0)

Command for synchronization:

UPL OUT "*WAI"

3.16.4.8 Driver for Screen and Keyboard STRINX.SYS

An internationally standardized software interface based on the ANSI standard X 3.41-1774 is provided for addressing the screen. This standard defines all functions required to operate a terminal. The most important functions of this standard as well as certain functions mainly required for operating the BASIC editor are implemented in the STRINX device driver.

This driver is loaded when booting the operating system, if

```
DEVICE = C:\UPL\DRIVER\STRINX.SYS
```

is contained in the configuration file CONFIG.SYS.

The following function groups are supported:

- Cursor control
- Labelling of status lines and softkeys
- Clearing screen areas
- Editing screen
- Setting the video attributes.

If the appropriate ANSI sequence can be assigned parameters P1; P2 ...; Pn, they must be entered as decimal numbers with one or two digits. The individual parameters are separated by semicolons.

The STRINX.SYS driver is to be used exclusively for programming in R&S BASIC. With this driver, the UPL is largely compatible with the PSA. ANSI.SYS has to be loaded for programs using the control sequences of the ANSI standard.

Cursor Control

The cursor can be set to absolute or relative positions. The output of new characters is continued starting at the set position.

Table 3.18 Cursor Control (UPL-B10)

Cursor function	Sequence	Example in BASIC
Free positioning (one parameter may be omitted)	ESC[P_1; P_2H *)	?"E^[05;32H"; Column Row
Shift cursor by P_n positions ↑ Shift cursor by P_n positions ↓ Shift cursor by P_n positions → Shift cursor by P_n positions ← (P_n with one digit only)	ESC[P_n A ESC[P_n B ESC[P_n C ESC[P_n D	?"E^[5A"; ?"E^[3B"; ?"E^[3C"; ?"E^[5D";
Shift cursor by one position ↑ ↓ with scrolling	ESC[: A ESC[: B	?"E^[:A"; ?"E^[:B";
Store cursor position / recall cursor position	ESC[s ESC[u	?"E^[s"; ?"E^[u";
Switch off cursor Switch on cursor	ESC[h ESC[l	?"E^[h"; ?"E^[l";

*) ESC means the key "Esc" or the keyboard code 1BH or 27 decimal

Labelling of Status Lines and Softkeys

Table 3.19 Labelling of Status Lines and Softkeys (UPL-B10)

Function	Sequence	Example in BASIC
Label status lines	ESCQP$_n$TEXT	?"E$_c$Q3TEXT"
Label softkeys	ESCRP$_n$TEXT	?"E$_c$R4TEXT"

Note:

The sequences must be terminated by LF (ASCII code 10).

Softkeys 1 to 4 cannot be labelled as they have been assigned important basic functions that must be available in all program states.

Status and softkey lines are labelled as follows:

Table 3.20 Labelling of Softkeys (UPL-B10)

Screen lines	VGA graphics mode *)
First	25 Q1
	26 Q2, Q
	27 Q3
	28 Q4, softk.
Last	29 Q5

*) Compatible with PSA mode

If one of the softkeys is labelled, the PSA compatibility mode is switched on (return with sequence "ESC[1j"). The keyboard codes are converted to the corresponding values of the PSA according to the following table:

Table 3.21 Labelling of Softkeys, Conversion table (UPL-B10)

PSA code	PC comp. scan code	Keyboard labels	
		German keyboard	American keyboard
0E0H	3B	F1	F1
0E1H	3C	F2	F2
0E2H	3D	F3	F3
0E3H	3E	F4	F5
0E4H	3F	F5	F4
0E5H	40	F6	F6
0E6H	41	F7	F7
0E7H	42	F8	F8
0E8H	43	F9	F9
0E9H	44	F10	F10
0EAH	45	F11	F11
0EBH	46	F12	F12
0B7H	47	Pos 1 7	Home
0B8H	48	↑ 8	↑
0B9H	49	Bild ↑ 9	Pg Up
0B4H	4B	← 4	←
0B6H	4D	→ 6	→
0B1H	4F	Ende 1	End
0B2H	50	↓ 2	↓
0B3H	51	Bild ↓ 3	Pg Dn
0B0H	52	Einfg 0	Ins
0AEH	53	Entf .	Del

Editing the screen

Table 3.22 Editing the screen (UPL-B10)

Action	Sequence	Example
Insert blank lines	ESC[P_nL	?"E_c[5L"
Delete lines	ESC[P_nM	?"E_c[3M"

Clearing Screen Area

Table 3.23 Clearing Screen Area (UPL-B10)

Cursor function	Sequence	Example in R&S BASIC
Clear screen, Cursor ↖	ESC[2J	?"E_c[2J"
Clear complete video RAM, Cursor ↖	ESC[3J	?"E_c[3J"
Clear from cursor to end of screen	ESC[J	?"E_c[J"
Clear from cursor to end of line	ESC[K	?"E_c[K"
Clear status and softkey lines **Note:** The sequence must be terminated by LF.	ESC[y	?"E_c[y"

Setting the colours

Colours may be assigned to each character output on the screen. The colours are also set via the ANSI interface.

Table 3.24 Setting the colours (UPL-B10)

Colour	b/w	Sequence	Example in R&S BASIC
light grey	light grey	ESC[91m	?"E_c[91m"
light grey	light grey	ESC[92m	?"E_c[92m"
yellow	white	ESC[93m	?"E_c[93m"
----	----	ESC[94m	?"E_c[94m"
blue	black	ESC[95m	?"E_c[95m"
dark grey	dark grey	ESC[96m	?"E_c[96m"
black	black	ESC[97m	?"E_c[97m"
black	black	ESC[98m	?"E_c[98m"

3.16.4.9 Operation of Serial Interfaces COM1 and COM2

The transmission rate, parity bit, number of data and stop bits as well as the error handling mode of the serial interfaces can be configured using the MS-DOS MODE program, which is described in section 2.16 Connecting External Devices or in the DOS manual (DOS commands). Configuration is made either automatically on calling the AUTOEXEC.BAT program, in the operating system by means of an entry via the keyboard, or in BASIC using the SHELL command. Example:

```
10 SHELL "mode com2: baud=24 parity=e data=7 stop=1 retry=n >NUL"
```

The last instruction for rerouting to the NUL device ensures that MODE does not output the response on the screen, but suppresses it.

The serial interface designated COM1 or COM2 is prepared for the output using the PRINT# command. As with every PRINT command, CR and LF are added to the string to be output if the line is not terminated by a comma or semicolon. Example:

```
10 OPENO #1,"com1:"
20 PRINT #1,A$
```

If the acknowledge lines DSR and CTS are not active, the operating system outputs the error message "ERROR 74 IN LINE xx: DOS: write fault".

The interfaces are prepared for reception using the OPEN command. With the subsequent INPUT# command, characters are read in until a CR is received. If the sending device continues to transmit characters, these characters must immediately be read in using the next INPUT# command, otherwise they are lost and an error is signalled. Timing becomes more critical the higher the transmission rates. If no characters are received (timeout), a zero is stored every 100 ms.

Example:

```
10 OPENI #1,"com1:"
20 INPUT #1,A$
```

The entry described above is for line-oriented text as characters are accepted until reception of CR. However, if the number of characters is known, the INPUT$() function ensures that any character and almost any number of characters can be received.

Example:

```
10 OPENI #1, "com2:"
20 A$=INPUT$( 100, #1)
```

Precisely 100 characters are read in. If less characters are received, the device waits 100 ms (specified timeout) for every expected character (and enters zero).

To wait for the start of the transmission, a character can be entered in a loop until the character is no longer zero.

Example:

```
20 REPEAT
30 A$=INPUT( 1, #1)
40 UNTIL ASC( A$) > 0
40 INPUT #1,B$
50 B$=A$+B$
```

3.16.4.10 UPL-Specific Error Messages From BASIC

ERROR 83: 'Instrument command allowed in this context'

The command is not allowed in this instrument state and depends on other settings. ('Execution error' with IEC/IEEE-bus control)

ERROR 84: 'Instrument param not within valid range'

The value of the command parameter is illegal.

ERROR 85: 'Instrument unit not allowed in this context'

The indicated unit is not allowed (in this state).

ERROR 87: 'Instrument option not installed'

The option required for this command is not fitted.

ERROR 88: 'Instrument ??? user error'

A user-correctable error has occurred during command execution (eg file not found).

ERROR 89: 'Instrument ??? system error'

An error has occurred in the MS-DOS or UPL software during command execution.

ERROR 90: 'Instrument invalid header string'

The actual command was not recognized (possibly because of a notation error).

ERROR 91: 'Instrument invalid parameter string'

The parameter of the command (string) is invalid.

ERROR 92: 'Instrument invalid unit string'

The unit of the command (string) is invalid.

3.16.4.11 UPL/BASIC Memory Management

The user need not be familiar with all the details, as the user automatically receives the CONFIG.SYS to be used and associated batch files with the program UPLSET described in section 3.16.3.

Since the memory available to MS-DOS programs is limited, the overlay technique is used in the UPL program. Furthermore, BASIC requires memory for the user program and its data (variables). These memory areas are assigned the parameters

-bp<n> for the program memory and
-bd<n> for the data memory.

Example:

```
upl_ui -bp16 -bd8
```

reserves 16k main memory for the program and 8k for the data, BASIC itself needing about 3k for its own management.

The minimum values are about 8k program and 4k data. BASIC can manage a maximum of 64k. However, with a size of about 2 times 32 k, the overlay memory for the UPL program decreases, reducing the program speed. More details cannot be given, since the available total memory, which may be occupied by resident programs and device drivers, may be very different.

The memory management of the UPL program is to be briefly explained in the following so that an experienced user can optimize his own configuration. The program and data memory used for BASIC is first reserved in the UMB area. If this is not possible (because the line DOS=HIGH,UMB is missing in the CONFIG.SYS, or too may other programs have been loaded into this area by LOADHIGH or DEVICEHIGH), the space in the conventional memory (below 640k) is used. If the remaining memory for the UPL program thus becomes too small, no memory is reserved for BASIC at all. The attempt to switch to BASIC then produces the error message "not enough memory for BASIC".

In memory models 64k plus 32k (or 32k plus 64k) also the device drivers are loaded into the UMB area. With 64k plus 64k the upper memory is completely full and the device drivers have to be stored in the conventional memory.

If space is to be used in the conventional memory, the size of the overlay memory is reduced. The UPL program may be restricted in its speed from a certain size onwards, which also depends on the memory required by other resident programs.

When executing BASIC, other instruments can also be controlled via the IEC/IEEE-bus interface. In this case, the UPL is the system controller via BASIC, i.e. it can no longer be remote-controlled by an external controller. The parser program UPL_IEC.EXE is no longer needed and must not be loaded any more when starting the UPL. Instead, BASIC requires the following device drivers:

STRINX.SYS	as BASIC editor
IECX.SYS	as IEC/IEEE-bus controller
GRAPHX.SYS	for the BASIC commands for graphics output
BEEPX.SYS	for audio outputs.

3.17 Remote Control via RS-232 Interface

As from UPL version 1.0 onwards, when an option UPL-B4 is purchased, remote control is not only possible via the IEC/IEEE bus but also via the RS-232 interface at the COM2 port at the rear of the instrument.

3.17.1 Preparation for Use

To activate the COM2 interface of the UPL for remote control select

```
Remote via      COM2
```

in the options panel.

To allow communication between controller and UPL via the RS-232 interface, the parameters of the two COM2 interfaces must be matched. The UPL parameters can be set with

```
COM2   PARAMETER   ------------
Baud Rate   2400     ...     56000
Parity      EVEN|ODD|NONE
Data Bits   7|8
Stop Bits   1|2
Handshake   XON/XOFF|RTS/CTS
```

in the options panel.
The meaning of the parameters can be seen in section 2.15.1 IEC/IEEE-bus Address

Use a zero-modem cable with the following assignment for interconnecting controller and UPL (2 x 9-pin female connector, R&S Order No. 1050.0346). This cable is suitable for RTS/CTS and XON/XOFF handshake.

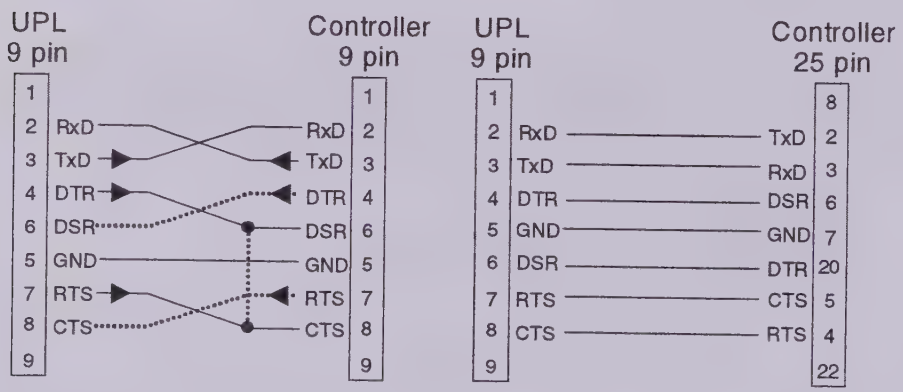


Fig. 3-42 Universal RS-232 cable, suitable for RTS/CTS and XON/XOFF handshake

RTS (request to send) is an output of the UPL which is set to TRUE (+12V) upon UPL switch-on. With **handshake = RTS/CTS** selected, UPL sets RTS to FALSE (-12V) when the UPL buffer is full during a data transmission from the controller to the UPL. In this case the controller must stop data transmission immediately until the contents of the data buffer have been processed by the UPL and RTS has been reset to TRUE. Normally, the RTS line of the UPL is connected to the CTS line of the controller. With **handshake = XON/XOFF**, RTS is not served by the UPL and remains set to TRUE.

DTR (data terminal ready) is an output of the UPL which is set to TRUE (+12V) upon UPL switch-on and which does not change. If the RS-232 interface of the controller requires the DSR (data nor ready)

input to be set to TRUE, it is best to connect DTR of the UPL to DSR of the controller. With **Handshake = XON/XOFF** selected, RTS of UPL is always TRUE. Thus DSR and CTS of the controller could be linked by means of a jumper on the PC connector (see dotted line).

CTS (clear to send) of the UPL is an input. If the UPL wishes to send data to the controller or plotter with **handshake = RTS/CTS** selected, it first checks whether the addressed device is ready to receive data. State-of-the-art devices normally signal their readiness to receive via the RTS output (older devices often via the DTR output). If the CTS input of the UPL is TRUE (+12V), UPL starts data transmission. If the data buffer of the addressed device is full, the RTS output is reset and the CTS input of the UPL is set to FALSE (-12V). As soon as the data buffer of the addressed device is empty, the device resets the RTS output and thus the CTS input of the UPL to TRUE and UPL continues data transmission. With **handshake = XON/XOFF** selected, the CTS input of the UPL is irrelevant and the connection CTS - ·- · RTS (dash-point line) is not required.

DSR (data set ready) of the UPL is an input which is not evaluated however. The line DSR - ··- ·· DTR (dash-dot-dot line) is not required.

3.17.2 Switchover to Remote Control

After power-up, the UPL is always in the manual operating mode (LOCAL state)") and can be controlled from the front panel or a keyboard. Control is switched to REMOTE as soon as a signal is identified at the RS-232 interface via COM2 in the remote control mode. During remote control the front-panel keys are disabled. The UPL remains in the REMOTE control mode.

3.17.3 Return to Manual Operation

UPL remains in the REMOTE control mode until switched to manual mode by means of the LOCAL key on the front panel or command SYSTem:GTL. A change from manual to remote control and vice versa does not change the instrument settings.

3.17.4 First Steps (Readout of Measurement Results)

A simple test of the RS-232 interface can first be performed with DOS commands from the PC.
Example:

- Connect the COM1 interface of the PC and the COM2 interface of the UPL using the zero-modem cable. If the COM1 interface of the PC is assigned to a mouse, the mouse may be connected to the COM2 interface of the PC using the adapter cable (9 → 25-way) normally supplied with the mouse.

- Set UPL in the OPTIONS panel to remote control using the RS-232 interface. The standard parameters of the COM2 interface, 9600 baud, even parity, 7 data bits, 1 stop bit, are set in the UPL.
  This standard setting is made when the BACKSPACE key is pressed during UPL switch-on (loading DEFAULT setup), *UPL -d* is entered at the DOS level and after (new) installation of an UPL software.
  On switching the UPL off and on or upon loading a setup, the "Remote via" settings and the parameters of the serial COM2 interface remain unchanged.

```
Remote via      COM2
          :
          :
PARAMETER    ------------
Baud Rate       9600
Parity          EVEN
Data Bits       7
Stop Bits       1
Handshake       RTS/CTS
```

- Adapt the COM1 interface of the PC to the COM2 interface of the UPL with DOS command *mode*:
  mode com1
  :9600,e,7,1
- Create an ASCII file with the name COMOUT.TXT at the PC using the DOS editor, which comprises the characters "*RST" (set UPL to default setting).
- Send the contents of file COMOUT.TXT to the COM1 interface:
- *copy COMOUT.TXT com1:*

UPL goes to the REMOTE mode and to the default setting.

- Although the described method allows control of the UPL, data cannot be read out as the copy command of DOS requires received characters to be terminated with the delimiter CTRL Z (1A hex) and UPL terminates its responses with a Line Feed (0A hex).

The following program examples demonstrate UPL control and read-out of measurement results via the RS-232 interface. For the three examples the RS-232 interface parameter should be set as described in section 3.17.4.

Because of the default setting with "*RST" (see Appendix A UPL Default Setup), the UPL generator produces a 1-kHz sinewave signal with a level of 0.5 V.
Command "INP:TYPE GEN2" internally links generator channel 2 and analyzer channel 1 so that no cabling of outputs and inputs is required. The UPL analyzer performs 10 RMS measurements and the results are displayed in the result field and on the controller screen.

Note:

A measurement result must be triggered before it can be displayed on the screen (`"INIT:CONT OFF;*WAI"`). After triggering, a settled result is available which can be queried, (`"SENS1:DATA1?"`), read in (comin) and displayed on the screen of the controller. (`PRINT . . .`).

3.17.4.1 Readout of Measurement Results in QuickBASIC

Enter the following program listing in Microsoft QuickBASIC (most of the PCs will use **QuickBASIC** under MS-DOS on the PC) and start with Shift-F5:

In QuickBASIC a maximum transfer rate of 19200 baud can be set (`OPEN "COM1:19200,E,7,1,RB100" FOR RANDOM AS #1`).
Since QuickBASIC does not support the hardware handshake RTS/CTS the size of the communication buffer (**RB value** in byte) had to be adapted to the expected data quantity and the controller speed: the slower the controller the larger the data quantity and the higher the RB value.

Every output string must be terminated with an LF (line feed) so that UPL is able identify the end of the command. In this program example the line feed is added generally to the output string in the `Comout` output routine (`PRINT #1, A$; CHR$(10)`).

```
'*************************************************
'* Triggering and output of 10 measurement results *
'*************************************************
DECLARE FUNCTION Comin$ ()
DECLARE SUB Comout (A$)

OPEN "COM1:9600,E,7,1,RB100" FOR RANDOM AS #1: '    Parameter of COM1
'The size of the communication buffer   (RB value in bytes) has to be
'adapted to the expected data quantity: The slower the controller the larger
the data quantity and the higher the RB value.
'For a single measurement result a few bytes will be sufficient,
'for a block data transfer of 1024 Y values of an FFT in ASCII
'format with a total length of more than 12000 bytes approx. RB5000
is required.
Comout ("*RST;*WAI"): '                          Loads default setup
Comout ("INP:TYPE GEN2"):'Connects analyzer input to generator output
FOR I = 1 TO 10
  Comout ("INIT:CONT OFF;*WAI"): '      Triggers and waits for result
  Comout ("SENS1:DATA1?"): '  Queries measurement result of channel 1
  PRINT Comin$: '            Reads out and outputs measurement result
NEXT I
CLOSE
END

FUNCTION Comin$
'*** Reading the response string of UPL at COM1 ***
' UPL terminates each output string with NL (CHR$(10)).
' Characters are read from the COM1 interface until NL is received.
X$ = ""
NZ: Z$ = INPUT$(1, 1): '           Reads single characters from COM1
IF Z$ <> CHR$(10) THEN X$ = X$ + Z$: GOTO NZ: '       Next character
Comin$ = X$: '                                 Returns complete string
END FUNCTION

SUB Comout (A$) STATIC
'*** Output of ASCII string at the COM1 interface ***
 PRINT #1, A$; CHR$(10): 'Each string must be terminated with NL (CHR$(10)).
END SUB
```

3.17.4.2 Readout of Measurement Results in R&S BASIC

Enter the following program listing in R&S BASIC and start with F2 (RUN).

When R&S BASIC is already installed on the controller, the COMX.SYS device driver allows the maximum UPL transmission rate of 56000 baud (`OPENI# 1,"com1:56000,e,7,1,2000"`) to be used.

Every output string must be terminated with LF so that the UPL is able to identify the end of a command (eg `"INP:TYPE GEN2"+CHR$(10);`).

```
10 '*************************************************************************
30 '* Triggering and output of 10 measurement results                       *
40 '*************************************************************************
50 OPENO# 2,"com1:"
60 OPENI# 1,"com1:9600,e,7,1,2000": '                    Set COM1 parameter
70 PRINT# 2,"*RST"+CHR$(10);: '  Sets default setup with internal connection
```

```
80 PRINT# 2,"INP:TYPE GEN2"+CHR$(10);: '      between generator and analyzer
90 FOR I=1 TO 10: '    Outputs 10 individually triggered measurement results
100 PRINT# 2,"INIT;*WAI"+CHR$(10);: '            Triggers measurement result
110 PRINT# 2,"SENS:DATA?"+CHR$(10);: '            Selects measurement result
120 GOSUB Comin: '                                     Reads out measurement
result
130 PRINT Instr$: '                                Outputs measurement result
140 NEXT I
150 END
160 '
170 '************** Reading in the UPL response ****************
180 Comin:
190 C$="": Instr$=""
200 Nexchar:
210 C$=INPUT$(1,#1): '                             Reads individual characters
220 IF C$=CHR$(10) THEN RETURN :  'Terminates reading when an LF is received
230 Instr$=Instr$+C$: GOTO Nexchar: 'Links individual characters to a string
```

3.17.4.3 Readout of Measurement Results in Borland-C 3.0

Enter the following program listing in Borland-C 3.0 and start with CTRL-F9 (RUN).

In Borland-C 3.0 a maximum transmission rate of 9600 baud can be set.

Each output string must be terminated with a line feed so that UPL can identify the command end (eg "INP:TYPE GEN2**\n**").

```
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <bios.h>
#include <dos.h>
#include <conio.h>

/*************************************************************************/
/*                              Declarations                             */
/*************************************************************************/

#define COM_1 0
#define COM_2 1
#define SETTINGS (_COM_9600 | _COM_CHR7 | _COM_STOP1 | _COM_EVENPARITY)

/*The following settings can be made in bios.h: */
// _COM_CHR7       0x02    /* 7 data bits */
// _COM_CHR8       0x03    /* 8 data bits */
// _COM_STOP1      0x00    /* 1 stop bit */
// _COM_STOP2      0x04    /* 2 stop bits */
// _COM_NOPARITY   0x00    /* no parity */
// _COM_EVENPARITY 0x18    /* even parity */
// _COM_ODDPARITY  0x08    /* odd parity */
// _COM_110        0x00    /* 110 baud */
// _COM_150        0x20    /* 150 baud */
// _COM_300        0x40    /* 300 baud */
// _COM_600        0x60    /* 600 baud */
// _COM_1200       0x80    /* 1200 baud */
// _COM_2400       0xa0    /* 2400 baud */
// _COM_4800       0xc0    /* 4800 baud */
// _COM_9600       0xe0    /* 9600 baud */
```

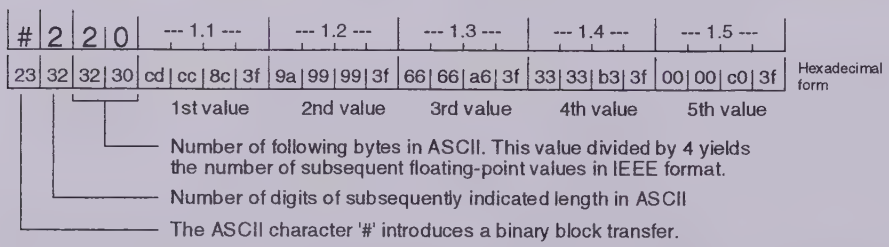
```
/*************************************************************************/
/* Initialization of interface */
/*************************************************************************/
void init_com(int port)
{
 _bios_serialcom(_COM_INIT, port, SETTINGS);}

/*************************************************************************/
/* Output of character */
/*************************************************************************/
void outp_char(int port,char c)
{
 _bios_serialcom(_COM_SEND, port, c);
}

/*************************************************************************/
/* Reading a character */
/*************************************************************************/
int inp_char(int port,char *to_rec)
{
unsigned int status;

 while (1)
 { /* Read until a character of error-free status is received */
  status = (_bios_serialcom(_COM_RECEIVE, port, 0) & 0x9fff);
  if ((status & 0x9f00) == 0)
   {
    *to_rec = (char)status;
    return (0);
   }
 }
}

/*************************************************************************/
/* Output of string */
/*************************************************************************/
void comout(int port, char *strptr)
{
 while (*strptr != '\0')
   outp_char(port,*strptr++);
}

/*************************************************************************/
/* Read string until a line feed is received */
/*************************************************************************/
void comin (int port, char *recptr)
{
int idx = 0;
char c = 0;

  while (1)
   {
    inp_char (port,&c);
    recptr[idx] = c;
    if (c == '\n') // Abort when LF is received
     break;
    idx++;
   }
  recptr[idx] = '\0'; // Overwrite NL with '\0'
}
```

```
/***************** Main program ******************/
/* Triggering and output of 10 measurement results */
/*************************************************/
int main ()
{
char recstring[100];
int i;

init_com(COM_1);

comout (COM_1, "*RST;*WAI\n");
comout (COM_1, "INP:TYPE GEN2\n");

for (i = 1; i <= 10; i++)
 {
  comout (COM_1, "INIT;*WAI\n");
  comout (COM_1, "SENS:DATA?\n");
  comin (COM_1, recstring);
  printf ("%s\n",recstring);
 }
printf ("Continue: ");
getch ();
return (1);
}
```

3.17.5 Differences to Remote Control via IEC/IEEE Bus

- A command line sent to the UPL must always be terminated with <New Line> (ASCII code 10, decimal). Since the character <Carriage Return> (ASCII code 13, decimal) before the delimiter is a filler without significance, the combination <Carriage Return> <New Line> is also permissible.

- **ASCII strings** sent by the UPL as a response to the controller via the RS-232 interface are always terminated with <New Line> (ASCII code 10, decimal).
  Block data in binary form are sent to the controller via the RS-232 interface without delimiter. The number of bytes can be seen from the digits sent ahead of the block data:


2 2 0 --- 1.1 --- --- 1.2 --- --- 1.3 --- --- 1.4 --- --- 1.5 ---
23 32 32 30 cd cc 8c 3f 9a 99 99 3f 66 66 a6 3f 33 33 b3 3f 00 00 c0 3f
Hexadecimal form
1st value
2nd value
3rd value
4th value
5th value
Number of following bytes in ASCII. This value divided by 4 yields the number of subsequent floating-point values in IEEE format.
Number of digits of subsequently indicated length in ASCII
The ASCII character '#' introduces a binary block transfer.

  Program examples 3.17.4.1 Readout of Measurement Results in QuickBASIC and 3.17.4.3 Readout of Measurement Results in Borland-C 3.0 illustrate the readout of binary block data.

- With remote control via RS-232 all the common commands related to SRQ control are not useful. This can be seen in the table under 3.9 Common Commands . An exception is the *OPC command. The main task of this command is to trigger an SRQ when a measurement result is available, but in the case of RS-232 control, it may be used to wait in a loop for a measurement result by querying bit d0 of the Event Status Register, see 3.17.4.1 Readout of Measurement Results in QuickBASIC.

- Common commands (3.13.1) and addressed commands (3.13.2) are not used in RS-232 control.

- With RS-232 remote control, an SRQ procedure cannot be programmed, ie the control program is not able to carry out another task while it waits for measurement results or error messages from the UPL.
  Error queue or status register must be queried cyclically in the control program.

- Since an SRQ routine is not available, there is no need to determine the sender or the source of an SRQ in a serial or parallel poll.

- Line messages like REN, GET, DCL, etc are not possible.

- The line message EOI denoting the end of a binary block cannot be used.
  If binary data are to be received nevertheless, the expected block length must be used instead.
  Remember that data bits = 8 and parity = NONE must be set for the receipt of binary data.

- All registers and commands of the status reporting system not referring to SRQ generation may be used:

*STB?	not usable
*SRE	not usable
*PRE	not usable
*IST?	not usable
***ESR?**	**usable**
*ESE	not usable
STATus:**OPER**ation**?**	**usable**
STATus:**QUES**tionable**?**	**usable**
STATus:**XQUE**stionable**?**	**usable**
SYSTem:**ERR**or**?**	**usable**

4 Maintenance and Troubleshooting

4.1 Maintenance

4.1.1 Mechanical Maintenance

- Clean the front panel and keys using a soft, damp cloth soaked with a liquid detergent, if required.
- Cleaning the LC display: do not use any acid solutions or abrasive cleaners (otherwise the anti-reflecting coat is damaged)! We recommend that standard cleaners as are used for optical devices such as glasses, objectives and the like or water mixed with some rinsing liquid be used for cleaning.

4.1.2 Electrical Maintenance

The UPL requires no electrical maintenance.

4.2 Function Test

Upon switch-on of the UPL the following self-tests are performed:

- Self-test on the computer. On the detection of any error the AT warning tone codes (see Table 4-1) will be audible. The system start is aborted, the UPL cannot be operated. With an external keyboard connected, the subsequent memory test can be aborted by pressing the "ESC" key.

Table 4-1 AT warning tone codes

AT-warning tone	Meaning
1	DRAM refresh failure
2	Parity Circuit failure
3	Base 64kB RAM failure
4	System Timer failure
5	Processor Failure
6	Keyboard Controller-Gate A20 error
7	Virtual Mode Exception Error
8	Display Memory R/W Test Failure *)
9	ROM-BIOS CheckSum Failure

*) non-fatal error

- Self-test on all boards of the measurement hardware including all options installed (recognized by the UPL itself). The self-test is carried out while the switch-on picture is being displayed on the screen and also during normal measurement procedures - however to a limited extent. On the detection of an error a message is displayed, which specifies the type of error, the name of the defective board and, if possible, a hint for the user how to eliminate the defect.

4.3 Troubleshooting

Error messages displayed after the self-tests or during a measurement usually contain a hint as to the cause of trouble and its elimination (see Section 2.3.6 Error Messages). If the cause is a defective board, it should be replaced (see 4.4 Replacing the Boards). For more details on the theory of operation of the measurement hardware boards and instructions on further fault locating, please refer to the Service Manual (order designation 1030.7551.24).

4.3.1 Replacing the SETUP Battery

Fault symptoms:

- The real-time clock or the data are incorrect upon switch-on of the UPL.
- The UPL does not run up.

Cause:
Lost setup, PC lithium battery discharged

The UPL contains a lithium battery for backing up the CMOS memory containing the computer setups when the UPL is switched off. The setups include operating parameters such as disk drives, memory organization etc. which the computer requires during system start. The instrument may fail completely when this setup or parts thereof are missing. Battery life is about 6 years.

Error recovery:
Replace the battery and reset the setup

Note: *An order no. for a spare battery is not given at this place since the current types will assumably no longer be available until failure of this battery. However, do not mind using regular batteries.*

Replacing the battery

UPL 05 incl. 80486 DX4/75 Board	Remove battery (contained in the black battery holder which is fixed to the board by means of a cable tie Insert new appropriate 3.4 V to 3.6 V lithium battery. Make sure that polarity is correct.
UPL 02 incl. 80386 DX40 Board	- Remove PCB (the large board in the upper chamber, installed upside down) - Either: Unsolder battery (=accu) (located next to the keyboard) and replace by a new MH or Ni-Cd accu (3.6 V) - or: use an ext. 3.4 to 3.6 V lithium battery (e.g., TADIRAN TL-5151). Remove jumper between pins 2 and 3 of pin connector J6 and connect cable of the lithium battery (4-pole, pin1= plus) (cf. Fig.). Fix battery using cable tie. - Refit PCB.

- Reinstall PCB.
- Reset SETUP (see next section)

4.3.2 BIOS-SETUP

It depends on the UPL model and the time of delivery, which controller boards and hard disk drives are supplied with the instrument. Thus, the operating menu for setting the SETUP parameters and the parameters, too, differ accordingly.
Operation of the setup menu is not explained since it may be obtained from the operator guidance lines.

Calling the SETUP menu

- Switch off the instrument, connect external keyboard.
- Switch on, press "DEL" key (or ENTF key with German keypad) and hold until the SETUP menu is displayed.
- Select menu item for setting the setup (e.g., "RUN CMOS SETUP", "STANDARD-SETUP", ...)
- Set according to the board and hard disk installed. The parameters to be entered are listed in the paragraphs below.

Note: *The setup menus assume an English keypad to be connected. With a German keypad, Y and Z have been exchanged compared to the English one (notice with acknowledging requests).*

Caution: *If the SETUP is not set correctly, this may lead to malfunction of the instrument! In this case, switch off the instrument, press "INS" key (or "Einfg" key with German keypad) and hold, switch on the instrument and release key with start of the memory test. The SETUP is thus reset to default values.*

SETUP for UPL 05 with 80486 DX4/75 Board

Table 4-2 Standard Setup (UPL05)

Date/Time	Current date /time
Floppy A	1,44 MB
Floppy B, Slave Disk	not installed
Hard Disk	use DETECT MASTER (s. u.)

Table 4-7 Chipset Setup (UPL 02)

Cache Read Option	3--1--1--1
Cache Write Option	1 WS
DRAM Waitstates	1 WS
Keyboard Clock Select	9.5 MHz
AT Clock	CPUCLK/5
16 Bit I/O Recovery Time	5/3 BCLK
CoProcessor Ready	No Delay
Non Cachable Area \#1 Size	Disabled
Non Cachable Area \#1 Base	Disabled
Non Cachable Area \#1 Type	DRAM
Non Cachable Area \#2 Size	Disabled
Non Cachable Area \#2 Size	Disabled
Non Cachable Area \#2 Type	DRAM
Memory Remapping	Enabled
Alle Shadow Optionen	Enabled

- Store setup

Note on memory expansion, if fitted :
The SIMM modules used have 72 contacts (PS2-SIMMs). 1Mx36 or 4Mx36 modules with an access time of 70 ns may be used..

4.3.3 Others

Fault symptom:

- After switch-on, the UPL is not in the same state as it was before switch-off. The last entries have been omitted.
- The following error message is displayed:

  "CMOS CHECKSUM ERROR. "

Cause:

Battery of test hardware discharged, since the instrument has long since been switched on.

The UPL contains a CMOS memory which stores all settings of all active panels and the data of the recorded traces. The settings of the other panels and the previous states of the active panels is saved on the hard disk, in addition. These data are still available after a failure of the battery. A capacitor bank is used as backup for the CMOS RAM when the instrument is switched off.

Error recovery:

Have the instrument switched on for at least four hours. The battery is then recharged and the settings are retained after switch-off.

Fault symptom:

The UPL does not respond in a sensible way or not at all on key depressions or IEC bus commands.

Cause:

The combination of previous settings resulted in an inadvertent program run causing the software to "crash".

Error recovery:

Restart the UPL!
Depending on the desired instrument setup take the following steps:

Restart the UPL with the instrument setup most recently stored in the CMOS-RAM.
This setup may be correct despite the faulty response of the UPL. To avoid having to enter again the settings most recently made, have a try at starting the UPL with this setup.

- Turn power switch off and on. (No further action possible).

  In case the procedure stated above fails, restart the UPL with its default setup.

- Connect external keyboard (see 1.1.6 Connecting an External Keyboard).
- Turn power switch off and on.
- When the UPL switch-on logo is displayed, abort the UPL program by pressing ESC and enter the DOS operating system level, where you can restart the UPL with its default setting by entering the command

  UPL -d eingegeben und mit ENTER quitiert wird.

The setup "DEFAULT.SET" in the "c:\upl\setup" directory supplied together with the UPL is loaded.

LOAD INSTRUMENT STATE in the FILE panel allows the loading of a setup which was stored by the user (see 2.9.1.1).

Further notes on software faults can be looked up in Section 2.3.6 Error Messages.

4.4 Boards Replacement

4.4.1 Opening the instrument

Replacing the Boards

- Disconnect the power connector the from UPL.
- Unscrew the feet from instrument rear (four Phillipps screws).
- Slide the upper panelling slightly to the rear and withdraw.

Important!
All boards are sensitive to electrostatic charge. Handle them in line with the ESD-regulations!

4.4.2 Boards Replacement

Any boards may be replaced without returning the instrument to the factory for recalibration.

The Service Manual (Order No. in the Data Sheet) supplies information on the replacement and what is to be noticed.

However, it is advisable to have the nearest R&S service center perform the replacement. Their staff is skilled for servicing this instrument and always informed on modifications and updates.

A UPL Default Setup

The default setup of the UPL is triggered by means of the settings below:

Manual setting in the FILE panel:	IEC/IEEE bus:
LOAD INSTRUMENT STATE Mode DEF SETUP	*RST

A precondition for the validity of basic settings is that the parameter link is switched off (see 2.15.8 Transfer of Parameters (Parameter Link Function)).

A.1 Default Settings of Generator

INSTRUMENT — ANALOG

- Channel(s) 2 = 1

For setting GENERATOR → ANALOG (default setting) the following applies:

- Output UNBAL
- Max Volt 12.000 V
- Ref Freq 1000.0 Hz
- Ref Volt 1.0000 V

For setting GENERATOR → DIGITAL the following applies:

- Src Mode AUDIO DATA — Further selections: JITTER ONLY I PHASE I COMMON ONLY
- PhaseToRef 0.0000 %FRM — with Src Mode PHASE only
- Channel(s) 2 = 1 — not with Src Mode COMMON ONLY
- Unbal Out AUDIO OUT
- Cabel Sim OFF
- Sync To AUDIO IN
- Sample Frq 48 kHz
- Sync Out GEN CLK
  Type WORD CLK
- Ref Out REF GEN
- Data ALL ZERO
- Audio Bits 20 — with Src Mode AUDIO DATAI PHASE only
- Unbal Vpp..1.0000 V
- Bal Vpp 0.0000 V
- Max Volt 1.0000 FS — with Src Mode AUDIO DATA I PHASE only
- Ref Freq 1000.0 Hz

- PROTOCOL STATIC
- Ch Stat. L ZERO
- Ch Stat. R EQUAL L

- AUX GEN OFF — with SRC Mode AUDIO DATA I PHASE only

For setting AUX GEN → ANALOG OUTthe following appliest:

- Channel(s) 2 = 1
- Output UNBAL
- SWEEP CTRL OFF
- Anlg Freq 1000.0 Hz
- Anlg Ampl 0.1000 V

The auxiliary generator (AUX GEN) has its own sweep system designed similar to the sweep system of the function generator. The function for a 2-dimensional sweep (Z axis), ie simultaneous frequency and level sweep, is not implemented. The default setting of commands is largely identical to the SWEEP CTRL points described for FUNCTION SINE in the section "Functions common to all generators".

For setting AUX GEN → COMMON MODE the following applies:

- SWEEP CTRL OFF
- Comm Freq 1000.0 Hz
- Comm Ampl 0.1000 V

For setting AUX GEN → JITTER the following applies:

- SWEEP CTRL OFF
- Jitt Freq 1000.0 Hz
- Jitt Ampl 0.1000 UI

Functions common to all generators

FUNCTION SINE

· Frq Offset	OFF	
· Low Dist	ON	ANALOG generator. If low-dist. generator option not installed: OFF
· DC Offset	OFF	with ON: 0.0000 FS or: 0.0000 V
· Dither	OFF	with DIGITAL generator

For setting Dither ON the following applies:

	0.0001 FS	with DIGITAL generator
· PDF	GAUSS	with DIGITAL generator
· Equalizer	OFF	
· Equal.File	R&S_EXAM.VEQ	with equalizer ON
· SWEEP	CTRL OFF	
· FREQUENCY	1000.0 Hz	
· VOLTAGE	0.5000 V[FS]	

For setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

· Next Step	ANLR SYNC	with AUTO SWEEP only
· X Axis	FREQ	
· Z Axis	OFF	

With X or Z axis → FREQ selected

FREQUENCY

· Spacing	LOG POINT
· Start	20000 Hz
· Stop	20.000 Hz
· Points	30
· VOLTAGE	0.5000 V [FS]

With X or Z axis → VOLT selected

· FREQUENCY	20000 Hz	
· Equalizer	OFF	
· Equal.File	R&S_EXAM.VEQ	with equalizer ON

VOLTAGE

· Spacing	LIN POINTS
· Start	0.0100 V[FS]
· Stop	0.5000 V[FS]
· Points	30

For setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

· Next Step	ANLR SYNC	with AUTO LIST only
· X Axis	FREQ	
· Z Axis	OFF	

With X or Z axis → FREQ selected

· FREQ.FILE	R&S_EXAM.SPF	with X or Z axis → FREQ selected

With X or Z axis → VOLT selected

· FREQUENCY	1000.0 Hz
· VOLT.FILE	R&S_EXAM.SPV

FUNCTION MULTISINE

· DC Offset	OFF	with ON: 0.0000 FS or 0.0000 V
· Spacing	USER DEF	
	10.000 Hz	
· Mode	DEFINE VOLT	
· Equalizer	OFF	
· Crest Fact	OPTIMIZED	
· Equal.File	R&S_EXAM.VEQ	with equalizer ON
· No of Sin	2	
· Multisine	CHOICE	
· TOTAL GAIN	0.0000 dB	
· TOTAL PEAK	1.0000 V[FS]	
· TOTAL RMS	1.0000 V	for INSTRUMENT ANLG only

For setting "No of Sin 17" and Crest Fact → OPTIMIZED *the following applies:*

Multisine

	Frequency	Voltage
1	1000.0 Hz	0.5000 V [FS]
2	40.000 Hz	0.5000 V
3	60.000 Hz	0.0000 V
4	120.00 Hz	0.0000 V
5	250.00 Hz	0.0000 V
6	310.00 Hz	0.0000 V
7	500.00 Hz	0.0000 V
8	1000.0 Hz	0.0000 V
9	2000.0 Hz	0.0000 V
10	4000.0 Hz	0.0000 V
11	6290.0 Hz	0.0000 V
12	8000.0 Hz	0.0000 V
13	10000 Hz	0.0000 V
14	12500 Hz	0.0000 V
15	14000 Hz	0.0000 V
16	16000 Hz	0.0000 V
17	18000 Hz	0.0000 V

Close

For setting "No of Sin 17" and Crest Fact → , OPTIMIZED *the following applies::*

Multisine

	Frequency	Phase	Voltage
1	1000.0 Hz	0.0000 °	0.5000 V [FS]
2	40.000 Hz	0.0000 °	0.5000 V
3	60.000 Hz	0.0000 °	0.0000 V
4	120.00 Hz	0.0000 °	0.0000 V
5	250.00 Hz	0.0000 °	0.0000 V
6	310.00 Hz	0.0000 °	0.0000 V
7	500.00 Hz	0.0000 °	0.0000 V
8	1000.0 Hz	0.0000 °	0.0000 V
9	2000.0 Hz	0.0000 °	0.0000 V
10	4000.0 Hz	0.0000 °	0.0000 V
11	6290.0 Hz	0.0000 °	0.0000 V
12	8000.0 Hz	0.0000 °	0.0000 V
13	10000 Hz	0.0000 °	0.0000 V
14	12500 Hz	0.0000 °	0.0000 V
15	14000 Hz	0.0000 °	0.0000 V
16	16000 Hz	0.0000 °	0.0000 V
17	18000 Hz	0.0000 °	0.0000 V

Close

FUNCTION **SINE BURST I SINE² Burst**

- DC Offset OFF with ON: 0.0000 FS or 0.0000 V
- SWEEP CTRL OFF
- FREQUENCY 1000.0 Hz
- VOLTAGE 0.5000 V [FS]

For setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

- Next Step ANLR SYNC with AUTO SWEEP only
- X Axis VOLT
- Z Axis OFF

With X or Z axis → VOLT selected

FREQUENCY 1000.0 Hz

VOLTAGE

- Spacing LIN POINTS
- Start 0.0100 V[FS]
- Stop 0.5000 V[FS]
- Points 30
- Low Level 0.0000 V [FS] for SINE BURST only
- ON TIME 0.0100 s
- INTERVAL 1.0000 s
- BurstOnDel 0.0000 s

With X or Z axis → FREQ selected

FREQUENCY

- Spacing LIN POINT
- Start 20000. Hz
- Stop 20.000 Hz
- Points 30 points 2 for SINE² burst
- VOLTAGE 0.0100 V [FS]
- Low Level 0.0000 V [FS] for SINE BURST only
- ON TIME 0.0100 s
- INTERVAL 1.0000 s
- BurstOnDel 0.0000 s

With X or Z axis → ON TIME selected

- FREQUENCY 20000 Hz
- VOLTAGE 0.0100 V [FS]
- Low Level 0.0000V [FS] for SINE BURST only

ON TIME

- Spacing LIN POINTS
- Start 0.0010 s
- Stop 0.2000 s
- Points 30
- INTERVAL 1.0000 s
- BurstOnDel 0.0000 s

With X or Z axis → INTERVAL selected

- FREQUENCY 20000 Hz
- VOLTAGE 0.0100 V [FS]
- Low Level 0.0000V [FS] for SINE BURST only
- ON TIME 0.0010 s

INTERVAL

- Spacing LIN POINTS
- Start 1.0000 s
- Stop 0.0200 s
- Points 30 points 2 for SINE² burst
- BurstOnDel 0.0000 s

For setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

· Next Step	ANLR SYNC	with AUTO LIST only
· X Axis	FREQ	
· Z Axis	OFF	

With X or Z axis → VOLT selected

· FREQUENCY	1000.0 Hz	
· VOLT FILE	R&S_EXAM.SPV	
· Low Level	0.0000 V [FS]	for SINE BURST only
· ON TIME	0.0100 s	
· INTERVAL	1.0000 s	
· BurstOnDel	0.0000 s	

With X or Z axis → FREQ selected

· FREQ FILE	R&S_EXAM.SPF	
· VOLTAGE	0.5000 V	
· Low Level	0.0000 V [FS]	for SINE BURST only
· ON TIME	0.0100 s	
· INTERVAL	1.0000 s	
· BurstOnDel	0.0000 s	

With X or Z axis → ON TIME selected

· FREQUENCY	1000.0 Hz	
· VOLTAGE	0.5000 V [FS]	
· Low Level	0.0000 V [FS]	for SINE BURST only
· ONTIM FILE	R&S_EXAM.SPO	
· INTERVAL	1.0000 s	
· BurstOnDel	0.0000 s	

With X or Z axis → INTERVAL selected

· FREQUENCY	1000.0 Hz	
· VOLTAGE	0.5000 V [FS]	
· Low Level	0.0000 V [FS]	for SINE BURST only
· ON TIME	0.0100 s	
· INTV FILE	R&S_EXAM.SPI	
· BurstOnDel	0.0000 s	

FUNCTION	**MOD DIST**	
· Frq Offset	OFF	
· DC Offset	OFF	with ON: 0.0000 FS or 0.0000 V
· SWEEP CTRL	OFF	
· UPPER FREQ	4000.0 Hz	
· LOWER FREQ	40.000 Hz	
· Volt LF:UF	4.0000 :1	
· TOTAL VOLT	1.0000 V	

For setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

· Next Step	ANLR SYNC	with AUTO SWEEP only
· X Axis	FREQ	
· Z Axis	OFF	

With X or Z axis → FREQ selected

UPPER FREQUENCY

· Spacing	LOG POINTS
· Start	20000. Hz
· Stop	4000.0 Hz
· Points	30
· LOWER FREQ	40.000 Hz
· VOLT LF:UF	4.0000 :1
· TOTAL VOLT	1.0000 V [FS]

With X or Z axis → VOLT selected

- UPPER FREQ 20000 Hz
- LOWER FREQ 40.000 Hz
- VOLT LF:UF 4.0000 :1

TOTAL VOLTAGE

- Spacing LIN POINTS
- Start 0.0100 V[FS]
- Stop 0.5000 V[FS]
- Points 30

For setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

- Next Step ANLR SYNC with AUTO LIST only
- X Axis FREQ
- Z Axis OFF

With X or Z axis → FREQ selected

- UPP F.FILE R&S_EXAM.SPF if X or Z axis → FREQ selected
- LOWER FREQ 40.000 Hz
- VOLT LF:UF 4.0000 :1
- TOTAL VOLT 1.0000 V [FS]

With X or Z axis → VOLT selected

- UPPER FREQ 4000.0 Hz
- LOWER FREQ 40.000 Hz
- VOLT LF:UF 4.0000 :1
- TOT V.FILE R&S_EXAM.SPV

FUNCTION	DFD	
· Frq Offset	OFF	
· DC Offset	OFF	with ON: 0.0000 FS or 0.0000 V
· MODE	IEC 268	

For setting the IEC 268 mode the following applies:

- Equalizer OFF
- Equal.File R&S_EXAM.VEQ with Equalizer ON
- SWEEP CTRL OFF
- MEAN FREQ 12500. Hz
- DIFF FREQ 80.000 Hz
- TOTAL VOLT 1.0000 V

For setting the IEC 118 mode the following applies:

- Equalizer OFF
- Equal.File R&S_EXAM.VEQ with Equalizer ON
- SWEEP CTRL OFF
- UPPER FREQ 12500. Hz
- DIFF FREQ 80.000 Hz
- TOTAL VOLT 1.0000 V

For setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP the following applies:

- Next Step ANLR SYNC with AUTO SWEEP only
- X Axis FREQ
- Z Axis OFF

With X or Z axis → VOLT selected

```
· MEAN FREQ   12500 Hz
· DIFF FREQ   80.000 Hz
TOTAL VOLTAGE
· Spacing     LIN POINTS
· Start       0.0100 V[FS]
· Stop        0.5000 V[FS]
· Points      30
```

UPPER FREQ with IEC 118 mode selected

With X or Z axis → FREQ selected

```
MEAN FREQUENCY
· Spacing     LIN POINTS
· Start       20000 Hz
· Stop        200.0 Hz
· Points      30
· DIFF FREQ   80.000 Hz
· TOTAL VOLT  0.0100 V [FS]
```

UPPER FREQuency with IEC 118 mode selected

For setting SWEEP CTRL → AUTO LIST or MANU LIST the following applies:

```
· Next Step   ANLR SYNC
· X Axis      FREQ
· Z Axis      OFF
```

with AUTO LIST only

With X or Z axis → VOLT selected

```
· MEAN FREQ   12500  Hz
· DIFF FREQ   80.000 Hz
· TOT V.FILE  R&S_EXAM.SPV
```

UPPER FREQuency with IEC 118 mode selected

With X or Z axis → FREQ selected

```
· MEANF.FILE  R&S_EXAM.SPF
· DIFF FREQ   80.000 Hz
· TOTAL VOLT  1.0000 V [FS]
```

UPP F.FILE with IEC 118 mode selected

FUNCTION RANDOM

```
· DC Offset   OFF
· Domain      TIME
· PDF         GAUSS
· VOLT PEAK   1.0000 V [FS]
· VOLT RMS    0.2550 V
```

with ON: 0.0000 FS or 0.0000 V

in analog generator only

For setting Domain FREQ the following applies:

```
· Spacing     USER DEF
              10.000 Hz
· Shape       WHITE
· Lower Freq  10.000 Hz
· Upper Freq  20000. Hz
· Equalizer   OFF
· Equal.File  R&S_EXAM.VEQ
· VOLT PEAK   1.0000 V [FS]
· VOLT RMS    1.0000 V
```

with equalizer ON

in analog generator only

FUNCTION ARBITRARY

```
· DC Offset   OFF
· Shape File  R&S_EXAM.TTF
· VOLT PEAK   1.0000 V [FS]
· VOLT RMS    1.0000 V
```

with ON: 0.0000 FS or 0.0000 V

in analog generator only

FUNCTION	**POLARITY**	
· DC Offset	OFF	with ON: 0.0000 FS or 0.0000 V
· VOLTAGE	0.5000 V [FS]	

FUNCTION	**FSK**	
· DC Offset	OFF	with ON: 0.0000 FS or 0.0000 V
· VOLTAGE	0.5000 V[FS]	

A.2 Default Settings of Analyzer

INSTRUMENT — ANLG 22kHz

For setting ANALYZER ANLG 22 kHz and ANLG 110 kHz the following applies.

- Min Freq 10 Hz — 20 Hz for ANLG 110kHz only
- Ref Imped 600.00 Ω
- Channel(s) 1
- Ch1 Coupl AC
- Ch1 Input BAL
- Ch1 Imped 600 Ω
- Ch1 Common FLOAT
- Ch1 Range AUTO

} The same settings apply with channel 2 selected

For setting ANALYZER DIGITAL the following applies:

- Meas Mode AUDIO DATA
- Min Freq 10 Hz — for Meas Mode AUDIO DATA only
- Channel(s) 1 — for Meas Mode AUDIO DATA only
- Input BAL (XLR)
- Sync To AUDIO IN — for Meas Mode AUDIO DATA only
- Sample Frq 48 kHz — for Meas Mode AUDIO DATA only
- Audio Bits 20 — for Meas Mode AUDIO DATA only
- Jitter Ref VARI (PLL) — for Meas Mode JITTER/PHAS only

START COND — AUTO

- Delay 0.0000 s

For setting START COND TIME TICK the following applies:

- Time 1.0000 s
- Points 30

For setting START COND FREQ CH1 | FREQ CH2 the following applies:

- Delay 0.0000 s
- Min Volt 0.0100 V [FS]
- Start 1000.0 Hz
- Stop 10000. Hz
- Variation 10.000 %
- Settling OFF

For setting START COND VOLT CH1 | VOLT CH2 the following applies:

- Delay 0.0000 s
- Start 0.0100 V [FS]
- Stop 1.0000 V [FS]
- Variation 10.000 %
- Settling OFF

For setting START COND LEV TRG CH1 | LEV TRG CH2 the following applies:

- Delay 0.0000 s
- Start 0.0100 V [FS]
- Stop 1.0000 V [FS]
- Variation 10.000 %
- Settling OFF

For setting START COND TIME CHART the following applies:

- Time 1.000 s
- Points 30

For setting START COND FRQ FST CH1 | FRQ FST CH2 the following applies:

- Delay 0.0000 s
- Min Volt 0.0100 V [FS]
- Start 1000.0 Hz
- Stop 10000 Hz
- Variation 10.000 %
- Settling OFF

For setting START COND FREQ CH1/2 | FRQ FST CH1/2 and Settling EXPONENTIAL ½ FLAT the following applies:

- Samples 3
- Tolerance 1.0000 %
- Resolution 0.0010 Hz

For setting START COND VOLT CH1/2 | LEV TRG CH1/2and Settling EXPONENTIAL ½ FLAT the following applies:

- Samples 3
- Tolerance 1.0000 %
- Resolution 0.0010 V [FS]

Functions common to all analyzers

Input measurement for analog analyzers

INPUT DISP	**PEAK I RMS**	
· Unit Ch1	V	
· Unit Ch2	V	with two-channel measurement
· Reference	VALUE: 1.0000 V [FS]	

Input measurement for digital analyzer in Meas Mode AUDIO DATA

INPUT DISP	**PEAK I RMS**	
· Unit Ch1	dBFS	FS for RMS
· Unit Ch2	dBFS	FS for RMS, with two-channel measurement
· Reference	VALUE: 1.0000 FS	

Input measurement for digital analyzer in Meas Mode COMMON/INP

INPUT DISP	**PEAK I DIG INP AMP**
· Unit Ch1	V
· Reference	VALUE: 1.0000 V[FS]

Input measurement for digital analyzer in Meas Mode JITTER/PHAS

INPUT/PHAS	**PEAK**	
· Unit Ch1	UI	%FRM for PHAS TO REF
· Reference	VALUE:	for PEAK only
	1.0000 UI	for PEAK only

INPUT/PHAS	**PHAS TO REF**
· Unit	%FRM

Frequency measurement for analog analyzers and digital analyzer in Meas Mode AUDIO DATA

FREQ/PHASE	**FREQ**	
· Unit Ch1	Hz	
· Unit Ch2	Hz	with two-channel measurement
· Ref Freq	VALUE:	
	1000.0 Hz	
· Freq Settl	OFF	

Frequency/phase measurement with two-channel measurement for analog analyzers and digital analyzer in Meas Mode AUDIO DATA

FREQ/PHASE	**FREQ&PHASE**	
· Unit Ch1	Hz	
· Unit Ch2	°	
· Ref Freq	VALUE:	
	1000.0 Hz	
· Format Pha	-180...+180°	Formatt Pha 0 to 360° for analog analyzer
· Ref Phase	VALUE:	
	10.000 °	
· Freq Settl	OFF	
· Phas Settl	OFF	

Frequency/group-delay measurement with two-channel measurements for analog analyzers and digital analyzer in Meas Mode AUDIO DATA

FREQ/PHASE	**FREQ&GRPDEL**
· Unit Ch1	Hz
· Unit Ch2	s
· Ref Freq	VALUE:
	1000.0 Hz
· Ref Phase	VALUE:
	10.000 s
· Freq Settl	OFF

Sample frequency measurement for digital analyzer in Meas Mode AUDIO DATA

FREQ/PHASE	**SAMPLE FREQ**	
· Unit Ch1	Hz	
· Unit Ch2	Hz	with two-channel measurement
· Ref Freq	VALUE:	
	1000.0 Hz	
· Freq Settl	OFF	
· Freq Settl	OFF	

Frequency and sample frequency measurement for digital analyzer in Meas Mode JITTER/PHAS I COMMON/INP

FREQ/PHASE	**FREQ I SAMPLE FREQ**
· Unit	Hz
· Ref Freq	VALUE:
	1000.0 Hz

common to all FREQ/PHASE settings:

For setting Freq Settl EXPONENTIAL | FLAT the following applies:

· Samples	3
· Tolerance	0.1000 %
· Resolution	0.1000 Hz
· Timeout	5.0000 s

For setting Freq Settl AVERAGE the following applies:

- Samples 3

For setting Phas Settl EXPONENTIAL | FLAT the following applies:

- Samples 3
- Resolution 0.1000 °
- Timeout 5.0000 s

For setting Phas Settl AVERAGE the following applies:

- Samples 3

Functions of all analyzers:

FUNCTION	RMS & S/N	
· DC Suppres	ON	for digital- analysator only
· S/N Sequ	OFF	for analogen analyzers only
· Meas Time	AUTO FAST	
· Unit Ch1	V [FS]	
· Unit Ch2	V [FS]	(with channel 2 activated)
· Reference	VALUE: 1.0000 V [FS]	
· Notch (Gain)	OFF	for analogen analyzers only
· Filter	OFF	
· Filter	OFF	
· Filter	OFF	
· Fnct Settl	OFF	
· POST FFT	OFF	
· SPEAKER	OFF	

For setting POST FFT = ON the following applies:

- FFT Size 4096
- Window RIFE VINC 2

FUNCTION	RMS SELECT	
· DC Suppres	ON	for digital- analysator only
· Meas Time	AUTO	
· Unit Ch1	V [FS]	
· Unit Ch2	V [FS]	if channel 2 is on
· Reference	VALUE: 1.0000 V [FS]	
· Sweep Mode	NORMAL	
· Bandwidth	BP 1%	with bandwidth BP FIX or BS FIX: 100.00 Hz
· SWEEP CTRL	OFF	
· FREQ MODE	GEN TRACK	
· Factor	1.0000 *	with FREQ MODE GEN TRACK only

For setting SWEEP CTRL AUTO SWEEP, MANU SWEEP the following applies:

- Spacing LOG POINTS
- Start 100.00 Hz
- Stop 20000. Hz
- Points 30

For setting SWEEP CTRL AUTO LIST, MANU LIST the following applies:

- Filename R&S_EXAM.SPF

For setting SWEEP CTRL GEN MLTSINE the following applies:
There are no further parameters

- Notch(Gain) OFF — for analogen analyzers only
- Fiter OFF — for analogen analyzers only
- Fnct Settl OFF
- SPEAKER OFF

FUNCTION PEAK & S/N — for analyzers ANLG 22kHz and DIGITAL only

- S/N Sequ OFF
- Meas Mode PK+
- Intv Time FIX 200ms
- Unit Ch1 V [FS]
- Unit Ch2 V [FS] — (if channel 2 is on)
- Reference VALUE: 1.0000 V [FS]
- Filter OFF
- Filter OFF
- Filter OFF
- Fnct Settl OFF
- SPEAKER OFF

FUNCTION QPK & S/N — for analyzers ANLG 22 kHz and DIGITAL

- S/N Sequ OFF
- Intv Time FIX 3
- Unit Ch1 V [FS]
- Unit Ch2 V [FS] — with channel 2 activated
- Reference VALUE: 1.0000 V [FS]
- Notch (Gain) OFF — for analog analyzers only
- Filter OFF
- Filter OFF
- Filter OFF
- Fnct Settl OFF
- SPEAKER OFF

FUNCTION DC — in analyzers ANLG 22 kHz, ANLG 110 kHz only

- Meas Time FIX 200ms
- Unit Ch1 V [FS]
- Unit Ch2 V [FS] — if channel 2 is on
- Reference VALUE: 1.0000 V
- Fnct Settl OFF
- SPEAKER OFF

FUNCTION THD

- Meas Mode All di
- Dyn Mode PRECISION — for analogen analyzers only
- Unit dB
- Fundamentl AUTO
- Fnct Settl OFF
- SPEAKER OFF

FUNCTION THD+N/SINAD

· Meas Mode	THD+N	
· Dyn Mode	PRECISION	for analog analyzers only
· Meas Time	SLOW	
· Rejektion	NARROW	for digital analyzer only
· Unit	dB	
· Fundamentl	AUTO	
· FILTER	OFF	
· FrqLim Low	100.00 Hz	128 Hz for ANLG 110kHz
· FrqLim Upp	20000. Hz	
· Fnct Settl	OFF	
· POST FFT	OFF	
SPEAKER	OFF	

For setting POST FFT ON the following applies:

· FFT Size	8192
· Window	RIFE VINC 3

FUNCTION MOD DIST

· Dyn Mode	PRECISION	for analog analyzers only
· Unit	dB	
· Fnct Settl	OFF	
· SPEAKER –	OFF	

FUNCTION DFD

· Meas Mode	d2 (IEC 268)	
· Dyn Mode	PRECISION	for analogen analyzers only
· Unit	dB	
· Fnct Settl	OFF	
SPEAKER –	OFF	

FUNCTION WOW & FL in analyzers ANLG 22 kHz and DIGITAL

· Standard	DIN/IEC
· Weighting	ON
· Unit	%
· Fnct Settl	OFF
· POSTFFT	OFF
· SPEAKER –	OFF

For setting POST FFT the following applies:

· FFT Size	8192
· Window	RIFE VINC 1

FUNCTION POLARITY

There are no further parameters

FUNCTION FFT

· DC Suppres	ON	with digital analysator only
· Unit Ch1	dBV [dbFS]	
· Reference	VALUE: 1.0000 V [FS]	
· Notch (Gain)	OFF	for analogen analyzers only
· FFT Size	4096	
· Window	RIFE VINC 2	RIFE VINC 3 for digital analyzers
· Avg Mode	EXPONENTIAL	
· Avg Count	1	
· Zooming	OFF	
· SPEAKER –	OFF	

For setting ZOOMING ON the following applies:

· Zooming	ON (2 to 128)	Zooming ON (2 to 8) for ANLG 110 kHz
· Center	10000 Hz	
· Span	21.94 kHz	SPAN 140.40 for ANLG 110 kHz In the digital analyzer, the value depends on the selected sample rate
· Zoom Fact	2	

FUNCTION FILTER SIM.

· Unit	%
· Filter	OFF
· Filter	OFF
· Filter	OFF
· SPEAKER —	OFF

FUNCTION WAVEFORM

· DC Suppres	ON	with digital analysator only
· Meas Mode	STANDARD	
· Unit	V [FS]	
· REF VOLT	1.0000 V	
· Filter	OFF	
· Trig Level	0.0000 V	
· Trig Slope	RISING	
· Interpol	1	
· Trace Len	0.0100 s	
· Trig Src	CHAN 1	for analog analyzer ANLG 22kHz only
· SPEAKER —	OFF	

FUNCTION PROTOCOL for digital analyzer only

there are no further parameters

FUNCTION COHERENCE

· Unit	%
· FFT Size	4096
· Window	RIFE VINC 2
· Avg Count	2
· Start	0.0000 Hz
· Stop	21938 Hz
· Resolution	11.719 Hz

FUNCTION RUB & BUZZ with analog analyzer only

· Meas Time	GEN TRACK	
· Unit Ch1	V	
· Reference	VALUE:	
·	1.0000 V	
· FREQ MODE	GEN TRACK	
· Factor	2.0000 *	
· Sweep Mode	NORMAL	
· Filter	OFF	
· FrqLim Low	100.0 Hz	
· FrqLim Upp	21938 Hz	120 kHz with analyzer ANLG 110 kHz only

Common to all measurement functions:

For setting SPEAKER unequal to OFF the following applies:

- Pre Gain 0.0000 dB with SPEAKER FUNCT CH1|2|1&2 only
- Spk Volume 30.000 %
- Phone Out = SPEAKER

For setting Fnct Settl EXPONENTIAL | FLAT the following applies:

- Samples 3
- Tolerance 0.1000 %
- Resolution 0.0010 V
- Timeout 5.0000 s

For setting Fnct Settl AVERAGE the following applies:

- Samples 3

A.3 Default Settings of Filter Panel

Basic parameters of filters:

Lowpass filter:
- Order 8
- Passband 20000. Hz
- Attenuat. 60.000 dB
- Short Name 1:LP20.0kHz

Highpass filter:
- Order 8
- Passband 400.00 Hz
- Attenuat. 60.000 dB
- Short Name 2:HP400.0Hz

Bandpass filter:
- Passb Low 900.00 Hz
- Passb Upp 1100.0 Hz
- Attenuat. 60.000 dB
- Short Name 3:BP900.0Hz

Bandstop filter:
- Passb Low 900.00 Hz
- Passb Upp 1100.0 Hz
- Attenuat. 60.000 dB
- Short Name 4:BS900.0Hz

Notch filter:
- Center Frq 16000. Hz
- Width 500.00 Hz
- Attenuat. 60.000 dB
- Short Name 5:NO16.0kHz

Octave filter (1/3 OCT FLT):
- Center Frq 12500. Hz
- Attenuat. 60.000 dB
- Short Name 7:TO12.5kHz

Oktave filter (OCTAVE FLT):
- Center Frq 12500. Hz
- Attenuat. 60.000 dB
- Short Name 8:OC12.5kHz

File-defined filter (FILE DEF):
- Filename R&S_EXAM.COE
- Delay 0.1000 s
- Short Name 9:R&S_EXAM

Standard filter types:

```
FILTER 01  LOW PASS
FILTER 02  HIGH PASS
FILTER 03  BAND PASS
FILTER 04  BAND STOP
FILTER 05  NOTCH FLT
FILTER 06  1/3 OCT FLT
FILTER 07  OCTAVE FLT
FILTER 08  FILE DEF.
FILTER 09  FILE DEF.
```

A.4 Default Settings of Display Panel

OPERATION BARGRAPH
- Scans COUNT 1
- User Label OFF

BARGRAPH A FUNC CH1
- Unit V [FS, Hz, dB, %] — Basic unit of selected analyzer or bargraph function (see section 2.4 Units)
- Limit Ref VALUE: 1.0000 V [FS, Hz, dB, %] — Basic unit of selected analyzer or bargraph function (see section 2.4 Units)
- Scale AUTO ONCE
- Spacing LIN

BARGRAPH B OFF

If the same function was selected for BARGRAPH B and BARGRAPH A:
- Scale B NOT EQUAL A

With Scale B → NOT EQUAL A selected :
- Unit V [FS, Hz, dB, %] — Basic unit of selected analyzer or bargraph function (see section 2.4 Units)
- Limit Ref VALUE: 1.0000 V [FS, Hz, dB, %] — Basic unit of selected analyzer or bargraph function (see section 2.4 Units)
- Scale AUTO ONCE
- Spacing LIN

BARGRAPH X VOLT
- Unit V [FS]
- Reference 10000 V [FS]
- Scale AUTO
- Spacing LIN

VOLT, FREQ, ON TIME and INTERVAL are displayed depending on the setting under X axis in the case of a generator sweep. For a sweep of the center frequency of the rms selective bandpass filter in the analyzer with measurement function RMS SELECT, FREQ is displayed.

BARGRAPH X FREQ
- Unit Hz
- Reference 1000.0 Hz
- Scale AUTO
- Spacing LIN

BARGRAPH X ON TIME | INTERVAL
- Unit S
- Scale AUTO
- Spacing LIN

LIMIT CHECK ———
- Mode OFF

For setting "Mode LIM LOWER, LIM UPPER, LIM LOW&UP" the following applies:
- Check TRACE A
- Lim Upper VALUE: 0.5000 V — not with LIM LOWER
- Lim Upper VALUE: 0.0500 V — not with LIM UPPER

A.5 Default Settings of Options Panel

```
· Remote via   IEC BUS
· UPL IECadr   20
· Beeper       ON
PARAM.LINK ————————
· Param Link   CHOICE...

SCREEN HARD COPY ———
```

with remote control option (UPL-B4) installed
not with remote control via COM2

Function tracking Gen → Anl selected

*For setting **Destin → PRINTR/SPC** the following applies:*

```
· Destin       PRINTR/SPC
· Printname    Default-Printer
· Frame Col    FILE DEF
· Comment      ON
· Left Mrgn    10   Chars
· Prn Resol    HIGH
· X Scaling    1.5000
· Y Scaling    1.5000
· Orientatn    PORTRAIT
```

Default Printer stands for the printer selected last by the user. If printer 0 is selected in the setup, loading the default setup does not overwrite the printer type selected by the user.

*For setting **Destin → PLOTTR/HPGL** / **PRINTR/HPGL** the following applies:*

```
· Destin       PLOTTR/HPGL | PRINTR/HPGL
· Color        OFF
· Copy         SCREEN
· Plot on      COM2
· IEC Adr      4
```

with Plot on = IEC BUS

*For setting Destin → **FILE/PCX** the following applies:*

```
· Destin       FILE/PCX
· Color        OFF
· Frame Col    FILE DEF
· Plot on      COM2
```

*For setting Destin → **FILE/HPGL** the following applies:*

```
· Destin       FILE/HPGL
· Color        OFF
· Copy         SCREEN
· Filename     SCREEN
```

*For setting Destin → **PRINTR/PS** / **FILE/PS** / **FILE EPS** the following applies:*

```
· Destin       PRINTR/PS | FILE/PS | FILE EPS
· Color        OFF
· Comment      ON
· Paper Size   A4
· Orientatn    LANDSCAPE
· Plot on      COM2
· Plots/Page   1


PRINT ————————————
· Type         OFF

COM2 PARAMETER ————
· Baud Rate    9600
· Parity       EVEN
· Data Bits    7
· Stop Bits    1
· Handshake    RTS/CTS
```

This standard setting is only set when the BACKSPACE key is pressed during UPL switch-on, UPL-d is entered or after a (new) installation of an UPL software.
COM2 parameters remain unchanged when a default settup is loaded. This prevents interface parameters, which have to correspond to those of the connected device, being overwritten by mistake.

```
PANEL KEYS  ————————
· Reptn Rate   10.000 Hz
· Rep Delay    0.5000 s

DISPLAY  ——————————
· Extrn Disp   BOTH AUTO
· Meas Disp    ON
· Read Rate    6/s
· Read Resol   CHOICE ...        Automatic for all 6 displays
TRACES COLOR/LINE ———
· Scan Conf    MANUAL
· Scannr. (A)  0
· Color    (A) GREEN
· Line     (A) ————————
· Scannr. (B)  0
· Color    (B) GREEN
· Line     (B) ————————

HELP LANGUAGE ———————
· Language     GERMAN

CALIBRATion    ANL ———
· Zero Auto    ON

CALIBRATion    GEN ———
· PhaseToRef   OFF
· DIAGNOSTIC   password ?
· Device       INSTALL KEY
· Option No.   0
· InstallKey   0
```

A.6 Default Settings of File Panel

```
LOAD INSTRUMENT STATE ——
· Mode          ACTUAL
· Info Displ    ON
· Filename      LASTSAVE

STORE INSTRUMENT STATE ——
· Mode          ACTUAL
· Attrib        READ/WRITE
· Info Text     no infotext
· Filename      LASTSAVE

STORE TRACE/LIST ————————
· Store         OFF

UTILS ——————————————
· Delete        TO_DELETE
· Work Dir      C:\UPL\USER
· COPY          SOURCE
· To            DEST
```

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